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ANNALS

OF THE

SOUTH AFRICAN MUSEUM

VOLUME XIII.

PART IV. *containing* :—

7.—*Notes on South African Mollusca.* By M. CONNOLLY.

I.—*Some South African Tiarinae.*

II.—*The Genus Marinula, King, with Diagnosis of an undescribed Species.*

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(With seven text-figures and four Plates, II.–V.)

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ISSUED APRIL 8th, 1915.. PRICE 7s. 6d

PRINTED FOR THE
TRUSTEES OF THE SOUTH AFRICAN MUSEUM
By WEST, NEWMAN & Co., LONDON.

7.—Notes on South African Mollusca.—By M. CONNOLLY.

I.—SOME SOUTH AFRICAN *Tiarinae*.

IN explanation of the above title, I would point out that, as the "Museum Boltinianum," 1798, is now accepted as valid in questions of nomenclature, Boltin's Genus *Tiara* * must take precedence of *Melania*, Lamarck, 1799.†

Boltin placed in *Thiara* five species :

The first is *Helix amarula*, Linné.

The second, which he named *cancellata*, appears to be identical with *setosa*, Swainson, ‡ in which case Boltin's name has priority.

The other three names are nude.

As *amarula*, Linné, was selected by Lamarck as the Type of *Melania*, and is the only species included by him when founding his Genus, it is obvious that *Melania* becomes a synonym for *Tiara* s.s., and is not even entitled to sub-generic rank.

The Subfamily *Melaniinae* therefore becomes *Tiarinae*, and, if the group of shells formerly classed as *Melaniidae* be considered worthy to rank as a distinct Family, *Melaniidae* gives place to *Tiaridae*.

I say *if*, because Bouvier § has shown that the nervous system and other portions of the anatomy in such species as *costata*, Q. & G., *amarula*, Lin., and *tuberculata*, Müll., present almost exactly the same relations as in *Cerithium vulgatum*, Brug., and Moore, || in his article on the Family *Melaniidae*, transfers this whole group to the *Cerithiidae*, as constituting simply the freshwater contingent of that Family. It seems doubtful, however, whether the generality of conchologists will concur in uniting two groups, one

* Mus. Boltinianum, Hamburg, 1798, part ii. p. 109 (as *Thiara*).

† Mém. Soc. Hist. Nat. Paris, 1799, p. 75.

‡ Quart. Journ. Sci. Lit. Arts, 1824, xvii. p. 13.

§ Ann. Sci. Nat. Paris, 1887, iii. pp. 125, 127, 153-156.

|| Proc. Mal. Soc., 1899, iii. p. 230.

marine and the other freshwater, which have so long been kept separate, and if the distinction is to be preserved, the name *Tiaridae* must be introduced.

With regard to the spelling, Bolten took his name *Thiara* from the French *thiare*, but the classical version, both in Greek and Latin, is *Tiara*, and as this has been adopted by H. & A. Adams* and Geoffrey Nevill,† among other authorities, the omission of the letter "h" is no innovation on my part.

Melania amarula (Lin.) was included in my "Revised Ref. List of South African non-marine Mollusca" on the strength of shells from Izezela and Umkomaas, which had been identified with that species.

I had not seen the examples in question, but, through the kindness of Mr. H. C. Burnup, have now been privileged to examine specimens from the Amanzintoti River, which he assures me are conspecific with those previously mentioned.

They are far smaller than typical *amarula*, and the spikes of the tiara are much less pronounced. I hardly think it possible to class them as *amarula*, Lin., and that species should therefore be removed from the South African list.

It is now necessary to find a name for these Natal shells.

They are unquestionably identical with the *Melania coacta* (Meusch.) ‡ of von Martens,§ recorded in 1897 from several parts of Zanzibar and the East Coast of Africa, and already included in the South African list, as it was found by Junod in Lorenzo Marques.

Even if Meuschen's species could be fully recognized, however, his name cannot stand, as the "Mus. Geversianum," in which he published it, has been ruled inadmissible from a binomial standpoint.

Brot|| and Mörch¶ have, on various occasions, associated *coacta*, Meusch., with *M. thiarella*, Lam.,** but there seems to be no actual proof of their identity, and *thiarella*, which was described from "Les grandes Indes," seems to be quite distinct from the East African species.

I think it may hence be concluded that (i) the name *coacta*, of Meuschen, being published in an inadmissible work, is void, and available for re-employment if desired; (ii) that it had not been

* Gen. rec. Moll., i. 1854, p. 294.

† Hand List, ii. 1884, p. 278.

‡ Museum Geversianum, 1787, p. 294 (as *Strombus coactus*).

§ Deutsch-Ost-Afr., 1897, p. 197. Pl. VI, f. 36.

|| Conch. Cab., 1877, p. 291.

¶ J. de C., 1872, xx. p. 319.

** Hist. nat. An. s. Vert., viii. p. 432.

re-employed in such a manner as to invalidate it from future use, prior to 1897; (iii) that the African species of *Tiara*, now under consideration, had not been described or named until the year just mentioned; that von Martens established the name *coacta* by adopting it for a definite species; and that, as Meuschen is inadmissible and his idea of *coacta* open to doubt, the present species must be known by the name of *Tiara coacta* (von Martens).

Before quitting the subject it may be advisable to deal with Bolten's second species, *Tiara cancellata*.*

He gave this name to the large, broad-based, flat-spired variety, listed by Gmelin † as *H. amarula*, var. β , and badly, though recognizably, figured by Chemnitz, ‡ which now passes as *setosa*, Swainson.

In 1824 Swainson described § under this name an immature shell from Mauritius, which forthwith became the subject of a heated controversy between himself and Gray. || This ended by Gray proving, at least to his own satisfaction, that *setosa* was the species figured by Chemnitz, a view subsequently adopted by Brot. ¶

Judging from Swainson's original figure and locality, it appears doubtful whether his *setosa* does not represent the young state of *amarula*, rather than the species which now passes under Swainson's name, but, even if Gray's application of it is correct, Bolten's *Tiara cancellata* has priority by twenty-six years, so that it must obviously be adopted for the species in question.

POSTSCRIPT.—Since the foregoing Note was written, Suter has adopted the family name *Thiaridae* in his work on New Zealand Mollusca.** For reasons already given it seems desirable to modify the spelling, but in any case the authorship of the name must be attributed to him

* Mus. Boltenianum, Hamburg, 1798, part ii. p. 109.

† Syst. Nat. Ed. 13, 1790, i. 6, p. 3656, No. 126 β .

‡ Conch. Cab., 1786, ix. p. 159. Pl. CXXXIV, f. 1220, 1221.

§ Quart. Journ. Sci. Lit. Arts, 1824, xvii. p. 13.

|| Zool. Journ., 1824-5, i. pp. 253, 399, 523.

¶ Conch. Cab., 1877, p. 297.

** Man. N.Z. Moll., 1913, pp. xviii, 235.

II.—THE GENUS *Marinula*, King,
with *Diagnosis of an undescribed Species*.

Little notice has been taken of this genus for over thirty years, while much that was written by earlier authors is erroneous. I therefore hope that the following notes, made during the elucidation of the species hereinafter described, may be of use to future students of *Auriculidae*.

The genus *Marinula* was founded by King in July, 1832 (not 1835, the date usually quoted), to receive a new species from the Island of Chiloe, off the extreme south coast of Chili, which he named *Marinula pepita*.

His diagnoses of the genus and genotype are :—

“MARINULA. Nov. Genus.

T. ovato-producta, sub-solida; apertura ovata, integra; columella bidentata, et basin versus uniplicata; dentibus magnis sub-remotis conniventibus, superiore maximo; operculum nullum.

MARINULA PEPITA.

M. t. ovato-producta, viridi-fuscâ; anfractibus sub-tumidis; spira brevi; ap. nigricante; dentibus plicâque albidis; long. $\frac{7}{16}$; lat. $\frac{4}{16}$ poll.

Hab. ad ins. Chiloe. Mus. Brit. nost. Brod. G. Sowerby.”*

Several writers have attributed to King the statement that the animal differs from that of *Pedipes* in its foot not being transversely divided, but there is no mention of this in his published writings.

No difficulty should ever have arisen over King's genus or species. He mentions that there is a typical set in the British Museum, and it is there to this day, agreeing well with his description and labelled “Chiloe; Captain P. P. King, R.N.,” but, instead of *pepita*, the name on the front of the tablet is *nigra*, Phil.

The explanation of this mistake is as follows :—

In the Cuming collection are three tablets; on one is the Type set of *Auricula reclusiana*, Petit, from Colombia, labelled in Pfeiffer's writing “*pepita*, King”; on each of the others is a set of, apparently, a smaller form of the same species, but one is labelled *pepita*, King (Hab. Chile), and the other, *acuta*, Orb. (no Hab. given). These shells are neither *pepita* nor *acuta*; in fact, they do not belong

* Zool. Journ., 1832, v. pp. 343, 344.

to *Marinula* at all; but it was on two of these sets that writers of the mid-Victorian period based their idea of King's genus. In the Cuming collection also are two sets of the true *pepita*, labelled respectively, "*M. marinella*, King, Chili" (an apparent misspelling of the Generic name), and "*Marinula nigra*, Phil. var., Chiloe." Now, in 1844, Küster described and figured as *Auricula pepita* a shell from Chili, similar to those wrongly labelled *pepita* in the Cuming collection; and also described *Auricula nigra*, Philippi from Chiloe, afterwards substituting the name *A. marinella*, King, which he thought had priority.

The figure is very bad, but the description is that of the true *pepita*, which came from the same locality as the *M. nigra* and *marinella* published by Küster; and the substitution of the latter name is obviously due to the above-mentioned misspelt label.

Although Gray more than once* mentioned *Marinula*, the first authors to make prominent use of it were H. & A. Adams, who, in 1854† included in the genus;—*pepita*, King (= *triplicatus*, Anton); *patula*, Lowe; *marinella* (= *nigra*); *callaoënsis*, Petit (nomen nudum); *recluziana*, Petit; *cymbaeformis*, Récluz (also nomen nudum); *punctata*, Bivona (= *villosa*, Fér. and *firminii*, Payr.); *aequalis*, Lowe (cum var. *gracilis*, Lowe), and a new species, *xanthostoma*, from Moreton Bay.

In 1855‡ they practically repeated the foregoing list, but founded a new subgenus *Monica*, to contain *aequalis*, Lowe (Type), *firminii* and *gracilis*.

These three species appear to have no connection with typical *Marinula*, but I hardly see how they can be considered even subgenerically distinct from *Phytia*, Gray (= *Alexia*, Leach, 1847, nec Stephens, 1835). If they are, *Monica* stands ready to receive them.

In 1855 Swainson created a genus *Cremnobates*§ for three Tasmanian shells, which he described under the names of *C. cornea*, *parva* and *solida*. Hedley & Suter|| have shown that *cornea* and *solida* are respectively synonyms of *Ophicardelus australis*, Q. & G., and the *M. patula*, Lowe, of Pfeiffer, and therefore propose *parva* as Type of Swainson's genus; but *parva* appears to be a true *Marinula*, in which case *Cremnobates* can only be relegated to synonymy.

* Syn. Brit. Mus., 1841, p. 91 and P.Z.S., 1847, p. 179.

† P.Z.S., 1854, p. 35.

‡ Gen. rec. Moll., ii. p. 246.

§ Papers and Proc. Roy. Soc. Van Diemens Land, 1855, iii. part i. p. 42.

|| Proc. Mal. Soc., 1910, ix. p. 151.

Pfeiffer, both in 1856* and 1857† placed in *Marinula*:—*pepita* (= *triplicatus* and *recluziana*); *acuta*, d'Orb; *nigra*, Phil (= *marinella* and *callaoënsis*); *patula*, Lowe (= *xanthostoma*, Ads. and ? *ovulus*, Fér.); *cymbaeformis*; *firmini*; *aequalis*; *gracilis*; and *abbreviata*, Beck; while in 1876‡ he included *vulcani*, Morelet, in the genus.

In 1864 Souverbie described a "*Marinula* an *Pedipes forestieri*, Montr.," from the New Caledonian Archipelago; in 1877 Vélain described *M. maindroni* and *M. nigra*, var. *minor*, from St. Paul's and Amsterdam Islands, and in 1878 Hutton described *M. filholi*, from New Zealand.

In 1880 von Martens § placed in *Marinula*:—*elongata*, Parreyss; *affinis*, Fér., and *conica*, Pease. In 1889, Paetel || further included *pellucida*, Cooper, and *subula*, Q. & G.; while finally, Pilsbry, in 1910, described *Marinula rhoadsi* from Mexico.

The following writers have also made special mention of the genus under discussion:—

1867 Paiva, Mon. Moll. Mad. p. 151.

1878 Wollaston, Test. Atlant. p. 267.

1880 Fischer & Crosse, Miss. au Mex. ii. pp. 3-5, 16, 27.

1882 Crosse & Fischer, J. de C. xxx. p. 179. Pl. VIII, f. 6.

The first two of the above papers relate to Madeiran shells, which have been wrongly attributed to *Marinula*; the third is of no special value as far as concerns that genus; but in the fourth the authors, dealing with the gradual absorption of the columellar folds during the growth of various genera of *Auriculidae*, state that in typical *Marinula* the destruction of the internal partitions attains its highest pitch, the interior of the shell being smooth, polished, and glossy red-brown.

Now if the shell of *Marinula* is to be separated on external characters from those of nearly allied genera, the points to be observed are:—

- (i) Shell fairly solid, unicoloured.
- (ii) Spire shorter than aperture.
- (iii) Whorls few, comparatively convex.
- (iv) No trace of tooth or plait on outer lip, which is not thickened; and not more than three folds, or plaits, on the columella.

* Mon. Auric. p. 59.

† Cat. Auric. p. 44.

‡ Mon. Pneum. iv. p. 331.

§ Meeresfauna Mauritius, p. 207.

|| Catalog, ii. p. 381.

Insistence must be laid on the inflated whorls and short spire, as otherwise there is hardly any conchological feature by which certain species of *Phytia* can be separated from *Marinula*, although the genotypes are quite distinct.

If the foregoing tests are applied to each of the 31 species which have been referred to King's genus, the following 17 can be at once eliminated; I give the earliest reference in each case, the letters *D*, *F*, *L*, *N*, *A*, & *R* signifying, respectively, Description, Figure of shell, Locality, Note, Anatomy, and Radula.

Ovatella punctata, Bivona, 1832. Effem. Sci. Lett. Sic. p. 58. Pl. I, f. 6. *D.F.*

A synonym of *Phytia firmini*.

Melampus aequalis, Lowe, 1832. Zool. Journ. v. p. 288. Pl. XIII, f. 1-5. *D.F.*

A Madeiran species which should apparently be placed in *Phytia*.

Auricula firminii, Payraudeau, 1826. Cat. Moll. Corse, p. 105. Pl. V, f. 9, 10. *D.F.*

A Mediterranean species of *Phytia*.

Melampus gracilis, Lowe, 1832. Zool. Journ. v. p. 288. *D.*

Another Madeiran shell, of which *vespertina*, Morelet, and *loweana*, Pfr., are considered synonyms, and itself, according to Wollaston, very nearly related to *Phytia myosotis* (Drap.)

Cremnobates cornea, Swainson, 1855. Pap. and Proc. Roy. Soc. V.D. Land, iii. 1, p. 43. Pl. VII, f. 1. *D.F.*

A synonym of *Ophicardelus australis*, Q. & G.

Auricula acuta, d'Orbigny, 1835. Mag. de Zool. p. 23. *D.*

Described from Guayaquil, and best placed in *Phytia*.

Pythia abbreviata, Beck, 1838. Index Moll. p. 105 (*without characters*).

Marinula abbreviata, Beck, Pfr. 1856. Mon. Auric. p. 65. *N.*

Pfeiffer remarks: "Absque ullâ indicatione, ex loco speciei inter *Pythiam aequalem* et *patulam* assignato forsan huc referenda?"; but whatever may be its true genus, as the shell is said to come from the Antilles it is quite unlikely to be a *Marinula*.

Auricula vulcani, Morelet, 1860. Notice sur l'Hist. Nat. des Açores. p. 207. Pl. V, f. 8. *D.F.*

Placed by Wollaston in the synonymy of *Phytia aequalis*, Lowe.

Pedipes forestieri (Montr.), Souverbie, 1864. J. de C. xii. pp. 41, 261. Pl. X, f. 1. D.F.

An immature shell from the New Caledonian Archipelago, the length of whose spire clearly separates it from *Marinula*.

Auricula elongata (Parreyss), Küster, 1845. Conch. Cab. p. 53. Pl. VIII (1844), f. 6. D.F.

A Sandwich Island species placed by Kobelt, 1898, in *Auriculastra*.

Pedipes affinis, Fér., 1821. Tabl. Syst. Moll. 3. p. 109 (or 113). D. Correctly placed by its author in *Pedipes*.

Laimodonta conica, Pease, 1862. P.Z.S. p. 242. D.

Also correctly placed, but *Laimodonta*, Ads., being preoccupied, has given place to *Enterodonta*, Sykes, 1894.

Auricula pellucida, Cooper, 1841. Microscop. Journ. p. 16. D.

This microscopic species has been shown by Hedley* to be a *Leuconopsis*. Specimens of *xanthostoma* having been erroneously circulated as *pellucida* gave rise to the misclassification.

Auricula subula, Quoy & Gaimard, 1832. Voy. Astrolabe, ii. p. 171. Pl. XIII, f. 39, 40. D.F.

Probably correctly placed by Kobelt, 1898, in *Auriculastra*.

Marinula rhoadsi, Pilsbry, 1910. Proc. Acad. Nat. Sci. Phila., lxii. p. 148, f. 1. D.F.

A Californian species, differing from *Marinula* in its less convex whorls and consequently more regular spire, while there is usually a banding of colour round the shell. It is perhaps best placed in *Phytia*.

Conovulus triplicatus and *Auricula recluziana* will be dealt with later on.

The names now remaining will be found to unite in a fairly homogeneous group, comprising seven Antarctic species whose shells all bear considerable resemblance to one another, and six, at least, of which are typical representatives of King's genus.

Taking them in geographical sequence from West to East, they are:—

pepita, King (= *nigra* (Phil.) Küst., *marinella*, "King" and *callaoënsis* (Petit) Ads.).

* Proc. Linn. Soc. N.S.W. xxxviii. 1913. p. 332. Pl. XIX, f. 85.

tristanensis, nov. (= *nigra*, Auctt., nec Küst.).

velaini, nom. mut. (= *nigra*, var. *minor*, Vélain).

maindroni, Vélain.

parva, Swainson.

filholi, Hutton.

xanthostoma, H. & A. Adams (= *solida*, Swainson; ? *cymbaeformis* Récluz, and ?? *patula*, Lowe).

I believe that I have examined every printed reference to these shells, and append all of any considerable importance; those which I have omitted are of a more or less check-list nature.

GENUS MARINULA, King, 1832.

Zool. Journ. v. 19. p. 343.

(= *Cremnobates*, Swainson, 1855, *pars*.)

MARINULA PEPITA, King.

1832 ?? *Melampus patulus*, Lowe, Zool. Journ. v. 19. p. 289. *D*.

„ *Marinula pepita*, King, Zool. Journ. v. 19. p. 344. *D*.

1841 *Auricula nigra*, Phil., Küster, Conch. Cab. p. 23. Pl. III, f. 4, 5. *D.F*.

„ „ *marinella*, King, Küster, Conch. Cab. p. 24. Pl. III, f. 4, 5. *D.F*.

1842 „ *pepita*, King, Rve., Conch. Syst. ii. Pl. CLXXXVII, f. 1. *F*.

1854 *Marinula marinella*, King, Ads., P.Z.S. p. 35.

„ „ *callaoënsis*, Petit, Ads., P.Z.S. p. 35.

1856 „ *nigra*, Phil. (*pars*) (= *marinella* and *callaoënsis*), Pfr., Mon. Auric. p. 61. *D*.

1857 „ „ „ „ Pfr., Cat. Auric. p. 45. *D*.

1878 *Auricula pepita*, King (= *nigra*, Phil.), Sow., Conch. Icon. Pl. V, f. 33. *D.F*.

Shell small, conic-ovate, imperforate, fairly solid, blackish-brown, interior rather milky. Spire produced, moderately acute, a little shorter than the aperture, apex very small, but sharp. Whorls 4, slightly convex, rapidly increasing, very faintly striate parallel to the lines of growth. Suture well marked but shallow. Aperture ovate, outer margin sharp, simple, edentulate; inner margin very slightly paler than exterior of shell, furnished with 3 white dental processes; —(i) a prominent, slightly incurved, receding tooth about 3 mm. from, and parallel to, the outer lip; (ii) a smaller, straight tooth at right angles to its base, nearly half-way between the foregoing

and the base of the columella; (iii) a hardly visible columellar plait just below the second tooth.

Dimensions of middle shell in Type set:—Long. 10·4; lat. 6·0; apert. $7\cdot1 \times 4\cdot5$; last whorl, 9·3 mm.

Other examples of the same set measure:—

Long. 10.3; lat. 6.2; apert. 7.0×4.2 ; last whorl, 9.4 mm.

„ 9·3; „ 5·5; „ 6·0×3·9; „ „ 8·0 „

Animal unknown.

Hab. SOUTH AMERICA. Chiloe Island, San Carlos Bay (King).

Type in British Museum.

In Pfeiffer's description of *M. nigra* he mentions that the right margin is sometimes furnished with several very indistinct transverse ridges; but I can see no trace of these in any of the shells which I have examined, and think it possible that the statement was based on imperfectly cleaned specimens.

It is so easy to confound Chile with Chiloe that it may be wiser to omit any of the more northerly localities which have been quoted for *M. pepita*. *M. callaoënsis* has never been described or figured, and although H. & A. Adams mention the species as being in the British Museum, I have been quite unable to find the shells in question. Pfeiffer was entirely mistaken about the true *pepita*, but his identification of *callaoënsis* with *nigra* may probably be accepted as correct.

Whether Lowe's *M. patulus* was really founded on this species, in which case the name would have priority, is discussed under *M. xanthostoma*, Ads.

MARINULA TRISTANENSIS, nov., 1915.

1856	<i>Marinula nigra</i> , Phil. (<i>pars</i>), Pfr., Mon. Auric. p. 61. <i>L.</i>
1857	" " " " " Cat. Auric. p. 45. <i>L.</i>
1877	" " " Vélain, Arch. Zool. Exper. vi. p. 126. <i>N.</i>
1907	" " " Melv. & Stand., Edinb. Trans. R. Soc.
p. 142. <i>L.</i>
1910	" " " Hedley & Suter, Proc. Mal. Soc. ix. p. 151. <i>L.</i>

Shell small, elongate-ovate, imperforate, solid, epidermis purple-black, interior and columella paler. Spire moderately produced, about two-thirds the length of the aperture; sides rather convex, apex minutely pointed. Whorls $3\frac{3}{4}$, not very convex, rapidly increasing, with fine, irregular striation following the lines of growth. Suture very shallow. Aperture acuminate-ovate, outer

lip thin, simple, inner furnished with three white dental processes—(i) a prominent, linguiform tooth parallel to, and about 1·7 mm. from the outer lip; (ii) a short, rather conical tooth about half-way between the upper one and the base; (iii) a minute columellar fold rather nearer the second tooth than the base.

Long. 10·4; lat. 5·5; apert. $6\cdot7 \times 4\cdot7$; last whorl 9·6 mm.

MARINULA TRISTANENSIS, sp. nov.

Epidermis purple-black; lines of growth eroded white.

Mr. G. C. Robson has very kindly examined the anatomy, on which I am therefore enabled to present the subjoined report:—

On the Anatomy of Marinula tristanensis.—By G. C. ROBSON, B.A.

(Published by permission of the Trustees of the British Museum.)

It was hoped that the ample material representative of this species, received for examination from Dr. Péringuey, would have afforded an excellent opportunity for giving a complete account of the anatomy of this interesting form, the generic position of which is now treated for the first time from the anatomical standpoint. It is to be regretted, however, that the specimens obtained were in such a state of contraction as to render dissection of anything more than the gross anatomy an impossibility. It was possible to make out a certain amount by sections stained with Haematoxylin and Methylene Blue, but the time available for continuing this method not being forthcoming the author is compelled to publish only such descriptions as may serve to indicate approximately the systematic position of the genus, together with a few other notes.

The *radula* (Fig. 1) differs in many well-marked characters from those of the genera usually regarded as closely akin to *Marinula*. There are in each row numerous teeth—about 230—the general form and disposition of which readily place it among the *Auriculidae*. The lateral teeth present a simple rounded main cusp with a slightly hollowed interior edge. The basal plate is produced very far beyond

the upper edge of each tooth and in a slanting direction. A transition to the marginal type of tooth is effected by the appearance on or about the thirty-fifth tooth of a small interior cusp on the acutely

FIG. 1.

Marinula tristanensis. Radula. ($4 \times \frac{1}{12}$ Homog. imm.)

pointed second cusp. The latter gradually divides into two and eventually more cusps appear until at about the 90th tooth four or five small, equal cusps are found arising from a somewhat amorphous basal plate.

The radula thus described clearly is distinguishable from that of *Melampus* and *Phytia*, although a family likeness is obviously present in all three.

The *jaw* (Fig. 2) is a typically Auriculid structure consisting of numerous loosely arranged fibres. It differs from that of *Melampus*, however, in being of a regular gently arcuate form slightly upturned at the extremities. At the latter the fibres are better developed and more regularly arranged than in the median area of the jaw.

The *genitalia* (Fig. 3). The organs of reproduction do not offer any singular departure from the usual Auriculid type although they are substantially different in disposition and form from those of *Melampus*, *Phytia*, and *Pythia*.

FIG. 2.

Marinula tristanensis. Jaw. (4×6 obj.)

The male genitalia do not differ very markedly from those of the three genera alluded to above in the presence or absence of any essential part. On the whole it is more like the slender delicate

system found in *Melampus*. It differs, however, from all three in having a number of muscle fibres inserted into the penis half-way down from the external aperture.

The female reproductive system appears to be considerably simpler than in any of the three other genera, and, if the author's

FIG. 3.

Marinula tristanensis. Genitalia. ($2 \times a^3$ Binoc. Zeiss.)

a. Penis. b. Penis muscle. c. Vas deferens; c', continuation of same. d. Accessory penis muscles. e. Vagina. f. Hermaphrodite duct. g. Gonad. h. Spermatheca (?).

interpretation is accepted, somewhat specialized, as the vas deferens, instead of splitting off the spermoviduct, has become completely separated from it and issues from the base of an accessory organ *

* This organ may possibly be an accessory glandular structure. If it is ultimately proved to be the spermatheca, then the absence of other accessory organs in the female generative system compares strangely with the condition seen in *Melampus*, *Phytia*, &c.

which appears to represent the spermatheca. If this interpretation is ultimately found to be correct the spermatozoa must be carried down the common duct to the vagina where they are separated from the ova and ultimately find their way to the exterior after traversing part of the spermathecal duct.

It remains to make one or two disconnected observations upon isolated points of anatomy.

(a) Portions of the resorbed shell septa are found in a superficial position in various parts of the body enclosed in epithelial pockets.

(b) The anterior edge of the mantle is supplied on the right-hand side with hard semi-calcified pads which no doubt act as protection against the rather formidable teeth of the shell aperture. The anus opens in a groove in one of these pads.

(c) The animal is apparently omnivorous, as the lower part of the intestine contained a variety of foraminiferan skeletons together with sand granules and fragments of a red crystalline substance.

Hab. INACCESSIBLE ISLAND, 'TRISTAN D'ACUNHA (Keytel (Type) and others). GOUGH ISLAND (Scotia Expedition, fide Melvill & Standen). SOUTH AFRICA. Camps Bay (Dale; McBean); Dassen Island (Lightfoot).

Type in South African Museum.

This species has long been known in collections under the name of *Marinula nigra* (Phil.), but as the last is merely a synonym of *M. pepita*, from Chiloe, a new name is necessary for the Tristan form.

The shell very closely resembles that of *pepita*, but the early whorls are rather less convex and the small columellar fold is, on the average, slightly more pronounced than in King's species, which, from its widely different locality, should surely be distinct.

I have not seen the examples mentioned by Melvill & Standen, but have no reason to doubt their identity with *tristanensis*, while their appearance on Gough Island furnishes a stepping-stone between Tristan d'Acunha and South Africa.

Only three specimens of *Marinula*, probably referable to *tristanensis*, have so far been collected in the last-mentioned sub-continent. Two of these, picked up at Camps Bay, near Cape Town, are somewhat beach-rolled, while the third, taken alive below high-water mark on the rocky shore of Dassen Island, is so

eroded as almost to have lost its shape; but taken together the shells appear to be a little longer in the spire and less solid than the generality of Tristan examples, and the interior is bright corneous instead of purple-brown. However, the difference in colour may be due to the effect of alcohol on the Tristan shells, while the length of spire is not a constant feature among specimens from the last-named locality, so that there are no good grounds for regarding the South African form as distinct from *M. tristanensis*, unless a larger series can be collected and proves to be specifically different.

MARINULA VELAINI, nom. nov., 1915.

1877 *Marinula nigra*, Phil., var. *minor*, Vélain, Arch. Zool. Exper. vi. p. 125 Pl. IV, f. 25. *D.F.*

Shell small, ovate-acuminate, imperforate, not very solid, dark corneous. Spire short, acute, sides very slightly convex. Whorls $3\frac{1}{2}$, very rapidly increasing, very slightly convex, with no sculpture except an occasional growth-line. Aperture large, acuminate-ovate, outer lip thin, simple. Columella furnished with 3 dental processes—(i) a long, curved tooth near, and parallel to, the outer lip; (ii) a shorter, curved tooth, at right angles to the columella and half-way between the upper tooth and base; (iii) a minute projection just below the foregoing.

Dimensions of a specimen in the British Museum: Long. 6·8; lat. 4·2; apert. $5\cdot0 \times 2\cdot2$; last whorl 6·3 mm.

Animal unknown.

Hab. ST. PAUL'S and AMSTERDAM ISLANDS (Vélain; McGillivray).

Type *ubi*?

The Type measured $7\cdot5 \times 4\cdot5$ mm., and the author states that the maximum size observed was $9\cdot0 \times 5\cdot0$ mm.

Vélain also remarked: "This *Marinula* is identical with that described from the Island of Tristan d'Acunha by Philippi under the name of *M. nigra*, but it is of much smaller size and must be considered as a var. *minor* of this species."

But even if *M. tristanensis* has reached the Atlantic coast of Africa, it is most unlikely to have found its way round the Cape and half-way to Australia; in addition to which, the disparity in size between it and Vélain's var. *minor* is constant and considerable.

On both geographical and conchological grounds, therefore, the latter should be separated from the Tristan shell, and, if really distinct from *M. maindroni*, it appears fully worthy of specific rank. I venture to name it in honour of its original describer.

MARINULA MAINDRONI, Vélain.

- 1877 *Marinula maindroni*, Vélain, Arch. Zool. Exper. vi. p. 126.
Pl. IV, f. 26. D.F.
1901 „ „ „ Kob., Conch. Cab. p. 284. Pl.
XXXIII, f. 24. D.F.

I have been unable to discover the whereabouts of the Type or a single example of this species. Vélain's diagnosis runs:—"Shell thin, short and globular, semitransparent, coloured bright brown; surface smooth and shining. Spire small, very acuminate, almost completely concealed by the last whorl, which is rounded and greatly developed. Aperture large, swollen towards the base; columellar margin not thickened, marked with much sharper folds than in the preceding species; outer margin thin and sharp, not sinuous. The shell measures $4 \times 3\frac{1}{4}$ mm."

Animal unknown.

Hab. AMSTERDAM ISLAND. "Dans les vacuoles des laves, assez rare."

I cannot help suspecting that the description might possibly refer to the young of the preceding species, but if such were the case Vélain would hardly have separated them, and it is only just to accept his verdict.

MARINULA PARVA (Swainson).

- 1855 *Cremnobates parva*, Swains., Pap. & Proc. Roy. Soc. V.D. Land,
iii. 1. p. 44. Pl. VII, f. 3. D.F.
1901 *Ophicardelus parvus*, Swains., Tate & May, Proc. Linn. Soc.
N.S.W. xxvi. p. 420. L.
1910 *Cremnobates parva*, Swains., Hedley & Suter, Proc. Mal. Soc.
ix. pp. 151, 152. D.F.A.R.
1913 „ „ „ Suter, Man. N.Z. Moll. p. 594.
D.A.R.

Shell small, imperforate, prolonged ovate-acuminate, rather thin, brown, corneous. Spire moderately produced, about one-third the length of the aperture; apex acute. Whorls 4, rather convex, very rapidly increasing, showing no sculpture except faintest irregular growth-marks. Suture fairly deep. Aperture ovate, peristome whitish, outer lip simple, acute, making almost a right angle, and thus appearing perceptibly swollen, at its junction with the paries. Columella white, thickened, with two dental processes;—the upper sharp and prominent, jutting out at right angles, equidistant between the apex of the aperture and the second tooth, which is shorter and

thicker, situate a little less than half-way from the base to the apex of the aperture.

Dimensions of a typical specimen from Tasmania, in the British Museum: Long. 9.2; lat. 5.3; apert. 6×3.6 ; last whorl 8.4 mm.

There is no epidermis, the shell appearing to be a little beach-rolled.

Hab. TASMANIA. Oyster Cove, near Hobart Town (Milligan); near Pirates Bay; Tasman's Arch (May).

Antipodes Islands (Bollons).

Type *ubi*?

Hedley and Suter selected this species as the Type of Swainson's genus *Cremnobates*, and published a few notes on its anatomy. This does not appear to differ to any considerable extent from that of *M. tristanensis*, as diagnosed by Robson in these pages, except that in *parva* "a central tooth could not be distinguished," while in *tristanensis* a central tooth is shown, but an infinitesimally small one. Without knowledge of the power of magnification employed, it is hardly safe for me to suggest that this feature may possibly exist and have been overlooked in the Tasmanian animal; but Mr. Robson informs me that it took a $\frac{1}{12}$ Homog. imm. objective to enable him to trace it in *tristanensis*.

The shell of *parva* is certainly that of a true *Marinula*, and, on the whole, there seems hardly sufficient cause for regarding *Cremnobates* as other than synonymous with King's genus, although, on the other hand, Hedley and Suter's description of the anatomy gives us no definite clue for uniting the two genera.

MARINULA FILHOLI, Hutton.

1878 *Marinula filholi*, Hutton, J. de C. xxvi. p. 42. *D.*

1880 " " " Man. N.Z. Moll. p. 34. *D.*

1913 " " " Suter, Man. N.Z. Moll. p. 591. *D.*

Shell small, prolonged ovate-acuminate, imperforate, pale corneous. Spire somewhat produced, nearly as long as aperture, sides convex, apex mamillate. Whorls $3\frac{1}{2}$, convex, rapidly increasing, finely microscopically striate parallel to the lines of growth. Aperture ovate, outer margin thin, simple; inner bearing three prominent white dental processes;—a long, thin tooth about equidistant between the outer lip and the next process, a smaller, conical tooth, which is situate a little more than half-way down from the apex of the aperture to the base; below the second, and parallel to it, is a still smaller tooth or fold, half the size of the central one.

Dimensions of a specimen from Chatham Island: Long. 7·4; lat. 4·5; apert. $4\cdot5 \times 2\cdot8$; last whorl 6·3 mm.

unknown.

Hab. NEW ZEALAND. Massacre Bay (Filhol); Auckland (Cheeseman); Banks Peninsula; Lyall Bay; Otago, alive on coast above high water (Iredale); Chatham Island (in coll. Connolly).

MARINULA XANTHOSTOMA, H. & A. Adams.

- 1821 ?? *Pedipes ovulus*, Fér., Tabl. Syst. iii. p. 109 (or 113). *D.*
 1832 ?? *Melampus patulus*, Lowe, Zool. Journ. v. 19. p. 289. *D.*
 1854 *Marinula xanthostoma*, Ads., P.Z.S. p. 35. *D.*
 „ „ *cymbaeformis*, Récl., Ads., P.Z.S. p. 35 (without characters).
 1855 *Cremnobates solida*, Swainson, Pap. & Proc. Roy. Soc. V.D. Land, iii. 1. p. 44. Pl. VII, f. 2. *D.F.*
 1856 *Marinula patula*, Lowe (= *ovulus*? and *xanthostoma*), Pfr. Mon. Auric. p. 62. *D.*
 „ „ *cymbaeformis*, Récl., Pfr., Mon. Auric. p. 63. *D.*
 1857 „ „ „ „ Cat. Auric. p. 47. *D.*
 „ „ *patula*, Lowe, Pfr., Cat. Auric. p. 46. *D.*
 1867 „ „ *xanthostoma*, Ads., Angas, P.Z.S. p. 231. *N.*
 1901 „ „ *patula*, Lowe (= *pellucida*, *xanthostoma*, and *solida*), Tate & May, Proc. Linn. Soc. N.S.W. xxvi. p. 419. *L.*
 „ „ „ „ (= *cymbaeformis*), Hedley, Proc. Linn. Soc. N.S.W. xxvi. p. 704. Pl. XXXIV, f. 18. *N.F.*

Before describing the shell, careful attention must be paid to the synonymy.

Férussac's diagnosis of *Pedipes ovulus* runs: "More elongated than *afra*, smooth and polished, and has not the internal rib on the external border of the aperture. *Hab.*?"

This might equally refer to a *Phytia* or *Marinula*, but it seems doubtful whence Férussac could have obtained an example of the latter genus. The Type of *ovulus* is not forthcoming, and in its absence the name is obviously worthless.

I do not think that *patula* can stand.

It has been impossible to trace the Type or a single authentic example of Lowe's species, which was unfigured and insufficiently described; but the following facts throw grave doubt on its being an Australian shell:—

When describing *Marinula pepita* in 1832, King mentioned that he had submitted his entire American collection to Sowerby, who had already obtained several of the species from other members of King's expedition.

Now in the same year Lowe described *Melampus patulus* from a shell received from Sowerby, and gave its measurements as $\frac{7}{16} \times \frac{1}{16}$ unc., which are identical with those given by King for *pepita*.

Errors of locality were frequent in those early days, and the translation of America into Australia would be a mere nothing, due to some one's misreading four letters of the name.

There is no proof that Pfeiffer was acquainted with originals of *patula*, and the fact of his connecting it with *xanthostoma* is easily accounted for by the locality.

Lowe's name of *patula* would take precedence of either *pepita* or *xanthostoma*, but, while the circumstantial evidence is strongly in favour of its application to the former rather than to the latter species, it may be advisable to retain the names which admit of no doubt, and to regard *patula* as a lost species pending the rediscovery of the missing type.

M. xanthostoma was founded by the brothers Adams on a set of well-preserved Queensland shells in the Cuming collection, while *C. solida* was described a year later by Swainson, from beach-rolled examples collected by Milligan on Flinders Island off the north coast of Tasmania.

The Type set of *xanthostoma* and good Co-types of *solida* are in the British Museum.

M. cymbaeformis was first mentioned in print by H. & A. Adams as having been described by Récluz in the Mag. de Zool. I can find no mention of any such name in Récluz' writings, and the species appears to have been first characterized by Pfeiffer from a shell in his own collection, purporting to come from the Island of Ticao, Philippines.

What this was I cannot say, but the Adams' set is probably still to be seen in the British Museum. It consists of 6 shells on one tablet labelled both "*patula*" and "*cymbaeformis*" and assigned to Ticao (in Cuming's writing) and also to Tanhay, I. of Negros, in the Philippine Islands. These are simply beach-rolled examples of typical Australian *xanthostoma*, and failing further proof to the contrary, the Philippine locality may, I think, be accepted as erroneous.

Pfeiffer also mentions a var. β , *gracilior*, from Australia. This appears to be represented on another British Museum tablet, which

contains 4 smaller shells collected by Strange at Moreton Bay. They are a slender form of *xanthostoma*, and show that it is a variable species.

The following description is from one of the Adams' Type set.

Shell acuminate-ovate, imperforate, not very solid, apparently somewhat beach-rolled, pale brown. Spire rather short, with nearly straight sides; apex very sharp, slightly produced. Whorls 5, rapidly increasing, the apical smooth and glossy, remainder marked with occasional faint, almost invisible striation in the lines of growth. Suture very shallow. Aperture a little longer than spire, ovate, base rounded, apex acuminate, outer lip sharp, simple; columella thickened, furnished with three white plaits; the uppermost linguiform larger and further, in proportion, from the others; the second, straight and much shorter, about half-way between the foregoing and the base of the columella; while the third, close below the second, is merely a small projection.

Long. 9.8; lat. 6.0; apert. 6.1×2.5 ; last whorl 8.6 mm.

There is an appearance of a faint interior rib, parallel to and just inside the outer lip, but this is probably an accident, due to the thinness of the edge of the lip owing to the shell not being quite mature, rather than a characteristic feature.

Animal unknown.

Hab. EAST AND SOUTH COASTS OF AUSTRALIA; TASMANIA.

Type in British Museum.

The typical form of *xanthostoma* is, in itself, on the extreme borderland of *Marinula*, having flatter whorls and a more acuminate spire than any of the preceding species; but in almost any large series intermediates may be found, which link it insolubly to the more normal form described by Swainson under the name of *solida*.

The latter differs markedly from the Adams' Types in its more elongate and convex spire and rather more pronounced upper tooth. It may be regarded, on the whole, as representing the southern form of *xanthostoma*, which appears to undergo a gradual transition in shape between its extreme limits of geographical distribution; but as neither form is constant, even among specimens from the same locality, and as *solida* is by no means an appropriate name for a form which is in reality less solid than the Type, it appears inadvisable to perpetuate it.

So far as I have been enabled to examine specimens from different localities, the typical form, as well as Pfeiffer's slender var. β , hail from Moreton Bay, Queensland: the extreme form of Swainson's so-called *solida* is in the great majority in sets from Flinders Island

(Milligan); Portland, Victoria (Cox); North coast of Tasmania (Brazier) and Cossacks, West Australia (Woodward); while examples almost exactly intermediate between the type and the variety have been found in New South Wales at Freemantle (Kemp) and Coogee Bay (Brazier).

The species is further recorded from King Island (Tate & May), and Shoalhaven and Port Jackson (Angas); but I cannot tell which forms are to be referred to these localities.

There is also a typical set in the British Museum labelled "New Zealand" (Hancock, 1856), but, although the authority is said to be reliable, it is very doubtful indeed whether living specimens have ever reached the Dominion.

It is earnestly to be hoped that the whole question of the distribution and varieties of *M. xanthostoma* will be taken up by some of the great Australian conchologists, and the anatomy examined with a view to the determination of its true generic position.

Distribution of *Marinula*. It would hence appear that *Marinula* is a truly Antarctic genus, originating in the Australasian region, with a circumpolar range extending eastward through New Zealand to Chiloe, and westward through St. Paul's and Amsterdam Islands and South Africa to Gough Island and Tristan d'Acunha. In the sole case where it extends northward, *e.g.* *M. xanthostoma*, the shell tends to lose its distinctive shape and to merge into *Phytia*; while in Africa and America it is confined to the extreme south of the continent and retains its normal form.

Its habit seems to be entirely marine, and it is questionable whether the genus would not be better included among marine, rather than non-marine Mollusca.

It now only remains to deal with the mis-named Cumingian shells which have been the cause of so much confusion. I have already mentioned that these occupy three tablets in the British Museum; one contains three larger shells from Tumaco Island, Colombia, and each of the others two smaller specimens, from "Chile" and an unknown locality respectively, which appear to be inseparable from the Tumaco examples.

We know that the Tumaco shells constitute the Type set of *Auricula recluziana*, Petit; but Pfeiffer considered them to be identical with *Conovulus triplicatus*, Anton, which was described from the River Maule, Chile, in 1839. This appears to be correct,

value in confirming, or correcting, deductions drawn from conchological features alone. Even now, however, more than one of the species, of which animals have been obtained, is represented by only a single spirit specimen, and others are not in the best condition, so that the results of their examination are not quite as satisfactory as would have been the case had a more complete representation been available.

It will be seen that Watson states that *Dorcasia* and *Trigonephrus* are nearly allied to each other, but differ considerably from other genera whose anatomy is known. They are rightly placed by Pilsbry in the Family *Acavidae*, and a new Sub-family, *Dorcasiinae*, may conveniently be founded to contain them.

The *Dorcasiinae* are distributed in all shapes and sizes along the south-western seaboard of Africa, from Algoa Bay to Damaraland, and in some instances also to a considerable distance inland.

I must confess that when I first undertook this paper, it was with the idea that many existing species could be shown to be hardly varietally distinct, and that, owing to the presence of connecting links, their names would be scarcely worth preserving. Extended study, however, tends to prove that most of the named forms exhibit quite sufficient and constant difference to entitle them to specific rank; while, in other cases, shells from the same locality constitute a local race of some species, consistently well defined, and so widely divergent from the Type that a name is advisable in order to prevent confusion.

From an anatomical standpoint, Watson places the genus *Trigonephrus* first and *Dorcasia* after it, and as his arrangement of the species, based on their anatomy, is perhaps the most convenient for comparison of the shells, I follow it in the ensuing pages.

The history of the *Acavidae* and all subsequent references to anatomical details are in the exact words of Mr. Watson, who has also furnished the figures of the animals, and my warmest thanks are due to him for his kind co-operation.

I may here mention that I have made no attempt to make my measurements, taken from the actual shells, agree with the figures, all of which are the natural size. Hardly any two persons will be found to measure a globular helicoid in exactly the same fashion, and a very slight accidental difference in the angle from which the shell is viewed or measured will account for a proportionate difference in the dimensions recorded.

As full references to every species were given in my "Revised Reference List of South African Non-marine Mollusca," published

two years ago in these ANNALS, they are omitted in the present instance.

FAMILY ACAVIDAE, Pilsbry, 1900.

Proc. Acad. Nat. Sci. Phila., p. 564.

It is generally believed that millions of years ago a great southern continent stretched westward from South Africa as far as the Andes, and eastward through Madagascar and Southern India to the Australian region. The climate of this continent was very cold towards the end of the Carboniferous period; but later it became warmer, and the snails that dwelt there flourished exceedingly, several new families being evolved. And one of these families seems to have been the *Acavidae*.

Now it is not difficult to form some idea as to what the first members of the *Acavidae* were like; for it is reasonable to suppose that they would possess any primitive characters that are still retained by some of their descendants, as well as such other features as are found in all the modern members of the family, or at least in all the more archaic genera. We may suppose, therefore, that the eggs of these snails would be larger than usual, and that the animals themselves would be above the average size. The shell would have a pointed spire and laterally compressed whorls; that is to say, both the shell and its aperture would be higher than broad. This is the form of shell found in the most primitive Euthyneura, such as the *Actaconidae*, the *Chiliniidae*, and the *Auriculidae*, as well as in many of the more ancient families of the Stylommatophora, and it is still retained by several members of the *Acavidae*. There would be the usual two pairs of tentacles, and the labial lobes would be well developed. The foot would have neither a definite peripodial groove nor longitudinal grooves on the sole. No caudal mucous pore would be developed. The lung would be rather short, and the pulmonary veins would branch over the whole of its roof, the first branch of the pericardial vein being nearly as large as the principal pulmonary vein. The excretory system would be unusually simple, the kidney being broad and probably without even a primary ureter. The nervous system would be of the type found in most of the more primitive snails and slugs, there being eleven separate ganglia. The cerebral ganglia would probably be rather near together, but the connectives uniting them with the remaining ganglia would be long. The jaw would be without ribs, but would probably have faint vertical striae and a

slight median projection. The radula would have nearly straight rows of "quadrate" teeth of the ordinary Helicid type, and the alimentary canal would pursue the usual course, though the difference in size between the two divisions of the liver would be less marked than is the case in most snails at the present day. The reproductive organs would be of a primitive type. A well-developed vesicula seminalis would be present, and there would be a swelling near the junction of the free oviduct and the duct of the spermatheca—a swelling which may have grown out into an appendiculum; but the spermathecal duct would have no diverticulum, and there would be no other accessory outgrowths of any kind. Though the penis and vagina would open together, a common vestibule would not have been developed. A considerable portion of the vas deferens, instead of lying freely in the body-cavity, would be still partially embedded in the invaginated portion of the skin which forms the wall of the penis. The retractor of the right upper tentacle would pass between the penis and the vagina.

Such we may suppose to have been the main characters of the earliest members of the *Acavidæ*. It will be seen that they were more primitive than many modern snails, but probably at the beginning of the Mesozoic era they were both larger and more highly organized than most of the other families then living. And the family increased and multiplied, and spread far and wide through that ancient southern continent. Moreover, both their multiplication and their spreading led to the further evolution of these snails.

As the individuals increased in number under the favourable conditions, they would become more crowded, and the competition between them would become more severe. This would lead to the evolution of higher types: unfavourable varieties would be eliminated; progressive mutations would alone survive. Thus the eggs grew larger and larger, or, in an extreme case, the animal became viviparous, the embryo reaching a relatively enormous size. The adult also became larger and broader, the whorls very much wider, and the apex more and more obtuse, until the form of the shell became globular, and finally depressed. The lip also became more expanded. A closed primary ureter was developed, and eventually the beginning of a secondary ureter.* The fine striae on the jaw either developed into ribs, or, more frequently, disappeared altogether. Similarly, the comparatively useless small secondary cusps on the teeth of the radula were generally eliminated, the main cusps becoming larger and broader at their expense. The reproductive

* See Randles, Proc. Mal. Soc., 1900, iv. Pl. IX, fig. 1.

organs also became simplified by the disappearance of any appendiculum or swelling at the junction of the free oviduct and the duct of the spermatheca; and, at the same time, the vas deferens gradually emerged from the wall of the penis and came to lie freely in the body-cavity.

Now evolution of this kind would proceed most rapidly in the central area where the family first arose, which was probably nearer Ceylon than South Africa; for, unless the local conditions were unfavourable, the individuals would be most densely crowded towards the centre, and there the competition would consequently be most severe. Towards the periphery of distribution, on the other hand, the individuals would be more sparsely scattered, and the primitive forms would therefore survive, as Taylor has maintained in dealing with other groups.

There is, however, another kind of evolution, which proceeds more rapidly towards the limits of the distribution of a group than in the centre; for as the animals spread in different directions they encounter new conditions to which they have to adapt themselves. This may lead to a profound modification of some of the organs; and if there are great differences in the environment, the various peripheral genera may differ more from the ancestral form than do those which still inhabit the central area. But the conditions seem to have been fairly uniform throughout that ancient southern continent; and although the peripheral members of the *Acavidæ* developed differences as they spread in various directions, they remained more primitive than those in the centre of evolution.

Until about the middle of the Mesozoic era the distribution of the family was probably continuous. And then there came the sea. First in one region and then in another, partly by denudation but chiefly by subsidence, that ancient continent gradually disappeared beneath the encroaching waves. The region extending from the south of India to Madagascar was cut off from Australia on the one hand and from South Africa on the other, and, later, Africa was separated from Brazil. Thus the old home of the *Acavidæ* was divided into four large islands. Henceforth each of the divisions of the family would develop independently, their separation accentuating their differences, until the *Acavidæ* were divided into four subfamilies, each inhabiting a different area.

The subfamily inhabiting the most westerly region, which included Brazil and the adjacent parts of South America, would be on the whole the most primitive, as it was furthest from the centre of evolution. So far as is known, none of the Heliciform members

of the family ever reached South America. Only the Bulimiform genera, *Strophocheilus* (including *Borus*) and *Gonyostomus*, are found in that region, and Plate has emphasized the very primitive character of these snails.* The researches of Semper,† von Ihering‡, Plate,§ and Pilsbry|| have shown that, besides retaining an elongate shell, these South American genera have a very simple kidney with no ureter, a radula in which the ectocones are usually still present on the marginal teeth, and a free oviduct which is swollen or provided with an appendiculum at its junction with the duct of the spermatheca.

But although these snails retain many primitive characters, they have undergone a considerable development under the favourable climatic conditions of Brazil. In some species the jaw has developed stout ribs. Many of the forms attain a great size, and have very big eggs. A large number of species have arisen, and they have spread over the greater part of South America, though they are still most abundant to the east of the Andes. To this subfamily Pilsbry has given the name of *Strophocheilinae*.

The subfamily which inhabits Australia and some of the neighbouring islands contains far fewer species; but so diverse are these that they are assigned to at least twice as many genera as the South American forms. Probably the group was once much commoner in the Australian region than it is at the present day.

The south of Australia is nearly as far from the centre of evolution as is Brazil, and, with the exception of *Anoglypta launcestonensis*, all the species from this region are more or less Bulimiform. Further north, however, we find the greatly depressed genus *Pedinogyra* in Queensland and New South Wales; while in the most northerly species of *Hedleyella*, instead of the spire having been flattened, the entire shell has become reduced, so that it can no longer contain the animal. The teeth of the radula have almost entirely lost their secondary cusps in this group,¶ and a primary

* Sitz.-Ber. Ges. naturf. Freunde, Berlin, 1896, p. 149.

† Reis. im Archip. Philippin., 1874, iii. p. 150. Pl. XIV, f. 10, Pl. XVI, f. 25, Pl. XVII, f. 1, Pl. F (1894), f. 5.

‡ Zeitsch. f. Wissensch. Zoologie, 1884, xli. p. 270. Pl. XVII, f. 6, and Bull. Scientifique, 1891, ii. p. 213. Pl. V, f. 11.

§ Op. cit.

|| Man. Conch., 1895, x. p. 1, and 1902, xiv. pp. iv-viii. Pl. XLIX, f. 8, Pl. LI, f. 16, Pl. LII, f. 26, 27, Pl. LIII, f. 35, Pl. LIV, f. 37, Pl. LVII, f. 59, 65-68.

¶ The ectocones, however, can still be distinguished in the marginal teeth of some specimens of *Anoglypta launcestonensis*.

ureter seems to have been developed, though further information is needed about the pallial organs of these snails. On the other hand, the fine striae on the jaw are retained in *Pedinogyra* and *Anoglypta*, and the vas deferens is still partially embedded in the wall of the penis in the latter genus. Moreover, the lip of the shell is unusually simple in this subfamily, the appendiculum is well developed, and the egg, though large, does not attain the enormous size found in some of the more highly specialized members of *Acavidae*. The penial retractor arises from the columellar muscle, or from far back on the floor of the lung, instead of near the front.

Hedley, to whom we owe so much of our knowledge of these snails, was the first to demonstrate that the Australian genera *Hedleyella*,* *Caryodes*, *Anoglypta*, and *Pedinogyra*, were related to one another, notwithstanding their striking external differences.† Semper had already remarked on the resemblance of *Hedleyella* to *Acavus* and *Helicophanta* from Ceylon and Madagascar,‡ but after comparing the anatomy of *Hedleyella* and *Caryodes* with that of *Acavus*, *Helicophanta*, and *Ampelita*, Pilsbry states that the relationship between the Australian and Indo-Madecassine genera is by no means intimate §. The Australian region has long been cut off from the other three areas in which the *Acavidae* are found, and contains a separate branch of the family, less primitive in some respects than the *Strophocheilinae*, but not so highly organized as *Acavus* and its allies. This subfamily may be named the *Caryodinae*.

The region extending from the south of Madagascar to the southwestern part of the peninsula of India remained a single large island, or a closely connected chain of islands, long after it was separated from the Australian region on the east and South Africa on the west; and it was probably not until Tertiary times that a series of faults, accompanied by subsidence, sent the greater part of that land beneath the Indian Ocean. The genera *Acavus* found in Ceylon, *Stylodonta* in the Seychelles, and *Helicophanta* and *Ampelita* in Madagascar, must therefore be regarded as the surviving remnants of a group which formerly also inhabited the intervening areas.

This group is that which lies nearest to the original centre of evolution of the family, and accordingly it includes the most highly

* *Hedleyella*, Iredale, 1914 (Proc. Mal. Soc., xi. p. 174) = *Panda*, Albers, 1860, nec van Heyden, 1826.

† Rec. Australian Mus., 1892, ii. p. 29.

‡ Reis. im Archip. Philippin., 1873, iii. p. 104.

§ Man. Conch., 1895, ix. p. 164.

organized members of the *Acavidae*. As in the *Caryodinae*, the most primitive forms are found in the south of the region, that is to say among the Madagascan species. Some of these have Bulimiform shells, while in the genus *Ampelita* the egg is only moderately large; but in all the genera of this subfamily, excepting *Ampelita*, the embryo attains a relatively enormous size before it is hatched or born (for *Stylodonta* is viviparous), and most of the Madagascan species, and all those from Ceylon and the Seychelles, have Heliciform or depressed shells. It is true that in some of the species of *Acavus* the spire is rather high, but this is almost certainly a case of reversion due to their having acquired arboreal habits. There is always a tendency among snails that live on trees or cliffs to become elongated, and the broad aperture of the shell in *Acavus* suggests that it was originally depressed. Moreover, in the two species of *Acavus* that are not arboreal, the spire is nearly flat. The shell is often highly coloured, and the lip, unlike that in the *Caryodinae*, is usually broadly expanded. Excepting in *Stylodonta*, all the teeth of the radula are without secondary cusps, and the jaw is without striae. An ureter is present. The reproductive system differs from that of the *Caryodinae* in being without an appendiculum; but in the Malagassy genus *Ampelita* Pilsbry has found that the vas deferens is still closely bound to the penis, as in *Anoglypta*.

This subfamily may be named the *Acavinae*, although Pilsbry originally included under this title the Australian genera also.* For our knowledge of the anatomy of this group we are indebted to the researches of Semper,† Viguiet,‡ Sarasin,§ Pilsbry,|| Wiegmann,¶ Randles,** and others; but we still know very little about most of the forms living in Madagascar.

As the land on which this subfamily arose extended as far as Southern India, one might perhaps have expected to find some members of the group in the peninsula. Possibly they may have once existed there; but, if so, they were probably unable to survive the competition of the more highly organized snails, belonging to the *Helicidae*, *Zonitidae*, and other families, which abound on the

* Man. Conch., 1895, ix, p. xxxii.

† Reis. im Archip. Philippin., 1873, iii, pp. 93-100. Pl. XII, f. 7-10, Pl. XVI, f. 5; and Nachrichtsbl. d. D. Mal. Ges., 1880, p. 60.

‡ Arch. Zool. Expér., 1880, viii, pp. 529-536. Pl. XL.

§ Ergeb. Naturwissensch. Forsch. auf Ceylon, 1888, i, pp. 35-69. Pls. VI-VIII.

|| Man. Conch., 1894, ix, pp. 149-156. Pl. XLVIII, f. 9, 12-14, Pl. XLIX, f. 19-23, 25, Pl. LI a, f. 1-6.

¶ Mitteil. Zoolog. Samml., Berlin, 1893, i, pp. 77-81. Pl. III, f. 3.

** Proc. Mal. Soc., 1900, iv, pp. 103-113. Pl. IX.

continent of Asia. Indeed it is somewhat remarkable that the family has survived even in Ceylon, for several of the more highly developed forms have invaded that island. Probably the *Acarinae* owe their survival to the protection and nourishment which they give to their young until the latter have reached a large size. A parallel may be drawn between the *Acarinae* and the Elasmobranch fishes. The Elasmobranchs form a very ancient group, which is far more primitive in most of its characters than the great majority of modern fish; yet they have survived to the present day and have attained an unusually large size. This is probably due to the care which they bestow upon their young: some have very big eggs like *Acanus*, others are viviparous like *Stylodonta*, but, in both cases, the young grow to a very large size before they make their appearance in the world.

We have now seen what happened to three of the four subfamilies into which the *Acaridae* became divided, when their original home broke up into four large islands. Only the African division remains to be dealt with.

The descendants of this branch of the family are now living in the west of the Cape Province and in the neighbouring part of German South-West Africa. As might have been expected, these snails are much more primitive than the *Acarinae*, being further from the centre of evolution. The eggs are not so large; the kidney is without an ureter; the jaw is striated, and secondary cusps are always present at least on the outer teeth of the radula. The reproductive system is without an appendiculum, but the free oviduct is usually much swollen, and the vas deferens is often closely bound to the penis.

Nor is it surprising to find that this subfamily has greater affinities with the *Strophocheilinae* than with the *Acarinae*, for recent researches have shown that the connection between Africa and Brazil probably remained long after the formation of the Mozambique Channel, although it is possible that Madagascar was reunited with Africa for a short period during Tertiary times, after the transatlantic connection had broken down. The resemblance between Pilsbry's figure of the pallial organs of *Gonyostomus multicolor*, from Southern Brazil, and the corresponding organs of *Trigonephrus* is undeniable; * and the irregular longitudinal folds which he shows inside the swollen free oviduct of the same South American species occur also in the South African forms. Moreover, the radula of this

* Cf. Man. Conch., 1902, xiv. Pl. XLIX, f. 8, with Pl. III, f. 1-4 in the present work.

species is very like that of *Dorcasia*, while in *Strophocheilus rosaceus* from Chili it is almost exactly intermediate between the types found in *Dorcasia* and *Trigonephrus*, and the jaw in the latter species is striate, as in the South African subfamily. Plate states that in *Strophocheilus ovatus* and *S. proximus* the duct from the posterior division of the liver opens into the muscular part of the stomach, while that from the anterior division opens into the thin-walled part in front of the muscular portion.* This is also the case in the South African snails, but in *Acarus* Randles states that both hepatic ducts open into the thicker-walled portion of the stomach.† Even the shell of *Borus* shows some resemblance to that of *Trigonephrus* in its colouring and the character of the lip; and in the form of the shell the most elongate species of *Trigonephrus* are not very unlike some of the South American species, such as *Strophocheilus* (*Borus*) *lutescens*.

As a whole, however, the South African subfamily is probably not quite so primitive as the *Strophocheilinae*; though here again we find that the southern genus *Trigonephrus* retains more primitive characters than *Dorcasia*, which is found further north. This is shown by the central tooth of the radula (which in *Trigonephrus* is of a more primitive type than in almost any other member of the *Acaridae*), by the shape of the kidney, and perhaps most strikingly by the shell; for in *Dorcasia* the shell is depressed, with a widely expanded lip, and has quite lost that resemblance to the Bulimiform members of the family which can still be traced in many of the species of *Trigonephrus*. There is, however, a small section of the latter genus in which the shell has also become depressed, and in which the reproductive organs have in some respects become more highly specialized than in the other southern species. Perhaps this may be due to a small secondary centre of evolution having arisen in the southern part of the area, where the conditions are more favourable than in the arid regions further north, and where the proximity of the coast may have led to some crowding of individuals. And possibly the evolution of *Anoglypta* in Tasmania might be attributed to a similar cause.

The climate of the Cape is much more like that of Europe than that of Brazil, and the South African *Acaridae* differ from the *Strophocheilinae* in that they have a strong resemblance in their external features to the true Helices of Europe. Indeed *Trigonephrus globulus* was once regarded as a variety of *Helix pomatia*,‡

* Sitz-Ber. Ges. naturf. Freunde, Berlin, 1896, p. 149.

† Proc. Mal. Soc., 1900, iv. p. 105.

‡ Chemnitz, Conch. Cab., 1786, ix. 2. Pl. CXXVIII, f. 1138c.

and until recently nearly all conchologists placed the species of both *Trigonephrus* and *Dorcasia* in the genus *Helix*. Not until 1905 was it discovered that these South African snails belonged to the *Acavidae*, and this is one of the many important discoveries which we owe to the wide researches of Dr. Pilsbry.* The resemblance between the South African and European forms is purely superficial: in their internal anatomy both *Trigonephrus* and *Dorcasia* are far more primitive than any of the dart-bearing *Helices*. This South African subfamily of the *Acavidae* may be named the *Dorcasinae*.

But why are these snails only found in the extreme south-west corner of Africa? Since they occur in Madagascar and the Seychelles on the one hand, and in Brazil on the other, we might have expected that the *Acavidae* would have a much wider distribution in Africa, and there can be little doubt that they once did inhabit nearly half the continent. It is therefore necessary to explain why their African distribution is now so limited. The reason is probably this.

Long after the advent of the *Acavidae*, perhaps not until the Cretaceous period, there arose in the tropics of Africa a new group of snails, the *Achatininae*. The earliest members of this group were small and slender, being scarcely distinguishable from the living *Stenogyrrinae*, but soon they grew amazingly, and adorned their shells with flaming streaks of colour. Larger and larger and very much broader became these snails until they resembled the *Acavidae*, especially the Bulimiform members of the family. The *Acavidae* were probably the only other large herbivorous snails in Africa, and with this family the *Achatininae* would inevitably come into competition. Now the *Achatininae* were a newer and more highly organized group than the *Acavidae*, and some of them became larger than any other snails on the face of the earth; it is therefore not surprising that the *Acavidae* gave way before them. The *Achatininae* multiplied and spread in all directions, and wherever they became abundant the *Acavidae* disappeared. They were too late to get all the way across to South America before the land-connection was broken by the sea; but they spread as far as St. Helena, and no members of the *Acavidae* are known to occur in that island. In the east the Mozambique Channel prevented them from invading Madagascar and the Seychelles, and the very few species of *Achatina* which are now found in those islands have probably made their way there comparatively recently. But there

* Proc. Mal. Soc., 1905, vi. p. 287.

was no barrier to prevent these large and vigorous snails from spreading southward; and southward they spread, exterminating the *Acavidae* as they went. When, however, they reached the south-west corner of Africa they found themselves on the horns of a dilemma: while the winter in this region was too cold to be agreeable to these snails of tropical origin, the summer was much too dry. Consequently their distribution received a check, and even to the present day very few members of the *Achatininae* have been able to penetrate into the area which lies west of the twenty-second degree of east longitude and south of the Tropic of Capricorn. In this region, therefore, the *Acavidae* have been able to survive; for the *Acavidae* is such an old family that it has had time to become acclimatized to all sorts of conditions, from the arid wastes of Namaland to the forests of Brazil.

Perhaps, in time, the *Achatininae* will evolve forms which are able to flourish in this region also, and then the *Acavidae* will be found no more on the African continent. But it seems more likely that the *Helices* which man has introduced into South Africa from Europe will constitute the most formidable competitors of *Trigonophorus* and *Dorcasia*. Civilization has upset the normal course of the evolution and distribution of animals; and, if the world lasts long enough, we might almost look forward to a time when all the larger snails and slugs in the temperate regions of the Southern Hemisphere will be of European origin.

DIAGRAM SHOWING THE POSSIBLE SPREADING OF THE *Acavidae*.

	Approximate area supposed to have been submerged in early mesozoic times.		
	Ditto	ditto	late mesozoic times.
	Ditto	ditto	early tertiary times.

If this history of the *Acavidae* is correct, the general course of the evolution of the family might be summarized as follows. The *Aca-*

vidae arose at the beginning of the Mesozoic era somewhere near the middle of Gondwanaland; and the members of the family spread east and west and south, and underwent upward evolution in the centre. Then that ancient southern continent gradually broke up into four large islands (one of which became subdivided later), and the *Acaridae* became divided into four subfamilies, one in each region. Lastly, some of these subfamilies began to be exterminated by newer and more highly organized groups of snails.

But this story of the evolution and distribution of the *Acaridae* may not be true. Hedley has suggested that the family arose on the Antarctic continent.* Now it must be admitted that the climate near the South Pole was once much more suitable for the evolution of snails than it is at present, and it is very probable that the Antarctic continent was at one time united to both Australia and South America. Possibly it may have been united to South Africa also, but it is not necessary to invoke the aid of this highly problematical land-connection before we can accept Hedley's theory. Since the *Dorcasinae* are so nearly allied to the *Strophocheilinae*, we might suppose that their ancestors had spread from the Antarctic to Africa by way of South America, having made use of the old connection between Africa and Brazil. Similarly the *Acarinae* might have reached their present home from the Australian region. But Hedley's hypothesis does not seem to explain the relative stages of development which have been attained by the different members of the family in so satisfactory a manner as the theory given above; and it certainly involves far greater assumptions; for we have no evidence at all that the *Acaridae* ever inhabited any part of the region which Hedley assumes was their original home. Moreover, Hedley's theory has been rejected by Pilsbry,† than whom there is no greater authority on the geographical distribution of snails. In writing about the *Acaridae*, Pilsbry goes so far as to state that "the radiation of this scattered group from the Palaeozoic Gondwana continent of Neumayr seems a reasonable, in fact the only tenable, hypothesis."‡

Far more information, however, is needed about the comparative anatomy of snails before we can attach any great value to theories concerning the origin and evolution of the various families. Possibly further researches may show a more intimate relationship between some of the subfamilies of the *Acaridae* than at present

* Proc. Linn. Soc., N.S.W., 1899, xxiv. p. 396.

† Rep. Princeton Univ. Exped. Patagonia, 1896-99, iii. (1911), p. 631.

‡ Rep. Princeton Univ. Exped. Patagonia, 1896-99, iii. (1911), p. 614.

seems probable. Or perhaps connecting links may be found between one or two of these groups and snails now placed in other families. The line drawn between the *Acavidae* and the *Helicidae* is still somewhat vague; and perhaps the gap which separates the *Acavidae* from the *Corillinae*, *Camaeninae*, and *Polygyrinae* may be no greater than that which separates these subfamilies from the more highly organized *Helicinae*. If this is the case it is possible that just as the dart-bearing *Helices* have probably arisen from the more primitive *Helicidae*, so these may have in turn been evolved from the *Acavidae*. On the other hand, those genera of the *Helicidae* in which the reproductive system is most like that of the *Acavidae* have generally been found to possess very different pallial organs; and there is some ground for believing that the *Helicidae* may have arisen further north than the *Acavidae*, and that the resemblance between some members of the two families may be entirely due to convergent evolution. Perhaps a comparative study of the structure of the pedal gland in the two families might throw some light on this question.

The affinities between the *Bulimulidae* and the *Acavidae* are a little less doubtful, for the more primitive members of these two families show a decided resemblance to each other. Pilsbry has demonstrated that it is almost impossible to distinguish the Bulimiform *Acavidae* from the *Bulimulidae* by their shells*; and in their internal anatomy some genera of the latter family show an undoubted similarity to the *Acavidae*. Thus, according to Pilsbry's description and figures,† the genus *Macrodontes* is remarkably like the *Acavidae* in its pallial organs, its jaw, its radula, its retractor muscles, and in the general features of its reproductive system; and yet *Macrodontes* is placed in the *Bulimulidae* near *Odontostomus*, a genus which it closely resembles in its conchological characters. The theory that the *Acavidae* have arisen from the same stock as the *Bulimulidae* is also supported by a comparison of the distribution of the two families; for we find that the *Bulimulidae* are widely distributed in those regions of the world to which the primitive Bulimiform *Acavidae* have also become restricted, but that they occur nowhere else.‡ While, therefore, the two families have evolved along widely divergent lines, it seems not unlikely that the Palaeozoic group of snails from which the *Bulimulidae* have descended gave rise to the *Acavidae* also.

* Man. Conch., 1902, Index to vols x.-xiv. p. vii.

† Man. Conch., 1901, xiv. p. 29. Pl. V, f. 37, 38, Pl. XV, f. 28, 29.

‡ See Rep. Princeton Univ. Exped. Patagonia, 1896-99, iii. (1911), p. 630, f. 37.

And now, having taken as it were a bird's-eye view of the *Acavidae* as a whole, let us examine more closely those members of the family that live in South Africa.

SUB-FAMILY DORCASIINAE, nov., 1915.

Shell rather large, perforate, elongate-globose to depressed-orbicular; fairly solid; usually almost unicoloured, with little ornamentation, transversely striate or costate, frequently showing malleation, but little or no spiral sculpture. Aperture large and toothless (except in *Tulbaghinia*), margin invariably thickened or reflexed.

External features of Animal.—Foot broad and rather short, more or less rounded at the hind end. Sole rather obscurely tripartite in *Dorcasia*, but undivided in *Trigonephrus*; covered by a ciliated columnar epithelium, and apparently without unicellular glands. Rest of skin divided into polygonal rugae. There are no well-marked peripodial, dorsal, or median posterior grooves, but a lateral groove runs down on each side from the mantle-edge to the head. The right lateral groove ends in the genital opening, which is almost as far forward as the upper tentacles, but lies nearer the foot. Beneath the lower tentacles there is a pair of broad and conspicuous labial lobes. No caudal mucous pore is present.

Mantle-edge thick, usually with right and left body-lobes. The left lobe is often divided into two widely separated portions, one near the respiratory opening, the other on the left side of the animal; but in most cases the two portions are united by a fold (see text-fig. 2, A, and Pl. IV., figs. 3-6). There are no shell-lobes.

Respiratory system.—Mantle-cavity or lung rather short. Pulmonary veins branching over the whole of its roof; usually rather more numerous between the respiratory opening and the pericardium and kidney than elsewhere, but never forming a very dense network. The first branch of the pericardial vein is almost as large as the main pulmonary vein, and runs forward nearly parallel to it, a large afferent vein lying between them. Beyond the first branch, the pericardial vein gives off one or two smaller branches, which alternate with afferent veins coming from the mantle-edge. Small efferent and afferent veins also cross the space between the rectum and the kidney and the main pulmonary vein (see text-fig. 2, A, and Pl. IV., figs. 1-6).

Heart and pericardium very oblique, the auricle lying nearer to the

rectum than does the ventricle. A single aorta arises from the hind end of the ventricle and then divides into two vessels, one passing backwards to the liver and adjacent organs, the other bending round the anterior loop of the intestine and running forwards to supply the cephalic region with oxygenated blood.

Excretory system.—Kidney somewhat triangular, very broad in the middle, but tapering in front and behind; its walls much folded internally. Anterior end scarcely projecting beyond the front of the pericardium, but abruptly curved round towards the rectum, thus forming a kind of hook. There is no ureter, but the kidney seems to open on the posterior side of this hook. From this point a band of modified epithelium extends along the edge of the mantle-cavity as far as the respiratory opening, running back along the side of the kidney, and then curving round the hind end of the cavity and passing forward next to the rectum. It thus occupies the position usually held by the ureter in the more highly organized Sigmurethra. In *Dorcasia* a slight ledge or fold runs along the side of the kidney and rectum, overhanging this band; and in *Trigonephrus*, though this fold is not found on the side of the kidney, it is sometimes present on the rectum, being especially developed in *T. lucanus* (Pl. IV., fig. 4).

Pedal gland opening below the mouth, and extending backwards for two-thirds of the length of the foot; usually embedded in the pedal muscles, but emerging into the body-cavity for the greater part of its length in some species of *Dorcasia*. Towards the hind end, the gland is approximately circular in transverse section, with a central duct. An irregular longitudinal fold projects from the roof of the duct into the lumen (text-fig. 1, A, C). The wall of the gland is composed of a very thick layer of radially disposed gland-cells, within which is a thin layer of circular muscles immediately surrounding the epithelium of the duct. This epithelium is peculiar, consisting of small, very narrow cells, which project into the duct like cilia. The fold, however, has a more ordinary columnar epithelium, composed of broader cells with granular contents. The centre of the fold is pigmented in *Trigonephrus porphyrostoma*. Further forward the gland becomes flatter and much wider, the internal fold being broadened out to form the roof of the widened duct (see text-fig. 1, B, D). The gland cells do not converge to open in a median groove in the floor of the duct with a longitudinal ridge on each side of it, and the structure of the gland differs widely from that of the European forms described by André.*

* Revue Suisse de Zool., 1894, ii. pp. 291-348. Pls. XII, XIII.

Central nervous system.—Nerve-ring surrounding the buccal mass, the cerebral ganglia often lying in front of the opening of the oesophagus, and the rather long cerebro-buccal connectives being therefore frequently directed backwards. Cerebral ganglia rather close together, the cerebral commissure being short. In *Trigonephrus* the cerebral ganglia and the nerves arising from them are more or less surrounded by darkly pigmented connective tissue.

TEXT-FIGURE 1.

Transverse Sections through the Pedal Gland in the *Dorcasinae* (somewhat diagrammatic).

- A. *Trigonephrus porphyrostoma* (M. & P.); section near hind end of gland, $\times 9$.
 B. " " " " " front end of gland, $\times 9$.
 C. *Dorcasia rogersi*, n. sp.; section near hind end of gland, $\times 15$.
 D. " " " " " front end of gland, $\times 15$.

The buccal retractor is innervated by a pair of nerves arising near the junction of the cerebral ganglia and the lateral connectives. Buccal ganglia widely separate, joined by a rather long commissure behind the opening of the oesophagus. Cerebro-pedal and cerebro-pleural connectives rather long. Pedal, pleural, parietal, and abdominal ganglia forming a compact ventral group, but none of them actually united, the abdominal ganglion tending to fuse

neither with the right parietal ganglion, as in the *Zonitidae*, nor with the left, as in the *Helicidae*. Left parietal ganglion much smaller than the other two visceral ganglia.

Digestive system.—Jaw of the usual crescentic form, with a slight median projection on the lower edge (except in *Trigonephrus globulus*); always without ribs, but covered with fine vertical striae (see Pl. IV., figs. 17–24). In *Trigonephrus* even fainter, though broader, oblique striae can also often be distinguished near the lower edge, diverging from the central projection.

Radula varying in size from 3.9×1.3 mm. in *Dorcasia rogersi* to $7\frac{3}{4} \times 4\frac{1}{4}$ mm. in *Trigonephrus rosaceus*, and possessing from 8,300 to more than 15,000 teeth (the number of teeth in each transverse row being a little less than the number of rows). Transverse rows straight or trending very slightly forward on each side. Bases of teeth quadrate, usually with a short flange projecting in front. Marginal teeth generally bicuspid; lateral and central teeth tricuspid in *Trigonephrus*, unicuspid in *Dorcasia*; but the transition from marginal to lateral teeth is very gradual. Central teeth not very much smaller than the laterals. (See text-fig. 2, B, and Pl. IV., figs. 9–16).*

Buccal mass muscular and rather large, the odontophoral muscles reaching back on each side as far as the end of the radula-sac in adult specimens of *Trigonephrus porphyrostoma* and *T. namaquensis*, so that in these species the end of the sac no longer projects as a papilla (compare Pl. IV., figs. 7, 8). Oesophagus and salivary ducts short (see Pl. IV., figs. 25, 26). Salivary glands generally meeting both above and below the alimentary canal, but only loosely united with each other. Crop narrow in the majority of specimens, but sometimes much distended, as in the example figured by Pilsbry.† In *Dorcasia coagulum* and *D. rogersi* the connective tissue surrounding the crop and salivary glands is darkly pigmented. Stomach sac-shaped, consisting of an anterior thin-walled portion in continuation with the crop, and a posterior portion with thicker muscular walls, from which the intestine passes

* The radula in this sub-family seems especially liable to malformation. In a specimen of *Trigonephrus globulus* belonging to Professor Gwatkin, as well as in one of the examples of *Dorcasia alexandri* var. *rotundata* dissected by the writer, the teeth in ten or fifteen adjacent transverse rows were all greatly shortened, and some of the outer marginals were suppressed altogether. In another specimen of *T. globulus* five of the teeth in each transverse row were abnormally large, being formed, in at least some cases, by the union of two adjacent teeth; and there were thus five separate longitudinal rows of abnormal teeth in the radula.

† Proc. Mal. Soc., 1905, vi. Pl. XIII, fig. 8.

forward ventrally. The intestine then bends upward and backward, and follows an S-shaped curve to the left of and above the crop and stomach, finally passing forward again into the rectum, which continues to the respiratory opening.

Liver consisting of two separate divisions of nearly equal size, the stomach lying between them. The anterior division is somewhat flattened, and is divided into three main lobes by the intestinal loops among which it lies. The ducts of these lobes unite to discharge by a single opening into the thin-walled portion of the stomach. The posterior division occupies (with the hermaphrodite gland) the upper whorls of the shell, and discharges by a duct opening into the posterior muscular portion of the stomach.

Free retractor muscles.—Right and left tentacular retractors separate from each other and from the "tail muscle" nearly to their origin on the columella. Each divides rather far forward into the retractors of the upper and lower tentacles, having first given off branches on its inner side to the anterior part of the foot. Right upper tentacular retractor passing between the penis and the vagina. Retractors of lower tentacles (and lips) thicker than usual. Buccal retractor generally united at its origin with the left tentacular retractor, but only for a very short distance excepting in *Dorcasia alexandri* var. *rotundata*; not bifurcating in front, but having a semicircular insertion around the under side of the buccal mass. Buccal protractors consisting of numerous small strands. Penial retractor arising dorsally from the front end of the floor of the lung.

Reproductive system (text-fig. 2, C, and Pl. V., figs. 1–8).—Hermaphrodite gland composed of numerous very narrow follicles embedded in the inner side of the posterior division of the liver. Hermaphrodite duct densely convoluted, but usually very slender, though somewhat swollen in *Trigonephrus gypsinus* and *T. lucanus*. Vesicula seminalis long and conspicuous. Albumen gland often very large. Common duct not convoluted or twisted. Free oviduct rather short, much swollen in *Trigonephrus*, and having irregular longitudinal folds projecting into its cavity. Receptaculum seminis, or spermatheca, oval, lying against the left side of the common duct. Receptacular duct usually moderately long, always without a diverticulum. Vagina long, excepting in *Trigonephrus globulus*, *T. gypsinus*, and *T. namaquensis*, in which it is rather short and slightly swollen. Genital atrium, or vestibule, extremely short, being scarcely developed at all.

Penis long and muscular, with internal longitudinal folds. In *Trigonephrus* these folds are corrugated (Pl. IV., figs. 27–29); in

Dorcasia both the folds and the intervening furrows are covered with diagonal rows of very minute papillae (Pl. IV., fig. 30). Penis-papilla absent or quite vestigial. Penial retractor attached to the posterior end of the penis, which is usually curved. A short epiphallus, lined by longitudinal rows of small papillae, is developed in *Trigonephrus* (excepting in *T. lucanus*), but it is not clearly marked off from the narrower vas deferens. The posterior part of the vas deferens next to the penis is slightly convoluted in *Trigonephrus*, and more strongly so in *Dorcasia alexandri* var. *rotundata*. In *Dorcasia* the vas deferens is usually only loosely united to the side of the penis, being nearly detached in *D. alexandri*, and in *Trigonephrus lucanus* it is quite free; but in the more globular species of *Trigonephrus* the vas deferens and epiphallus are very closely attached to the wall of the penis, the vas deferens being practically embedded in it towards the genital atrium in some forms, such as *T. namaquensis*. Followed backwards, the vas deferens bends under the female duct and curves up the right side of the swollen free oviduct in most of the species of *Trigonephrus*; and in these forms the receptacular duct arises on the left side. But in *Dorcasia* and in *Trigonephrus lucanus*, the vas deferens keeps to the left of the female duct, and the receptacular duct arises on the right side, and crosses over the junction of the free oviduct and the common duct.

Much connective tissue unites the vagina, free oviduct, and common duct to the adjacent body-wall; and at the junction of the two latter ducts this tissue is so abundant that it seems to form a partial septum across the body-cavity.

Spermatozoa (Pl. V., figs. 9-11).—Head varying in length from .005 to .006 mm.; tapering in front, and curving alternately to the right and left; broader behind, especially in *Trigonephrus*. Tail extremely long; proximal portion, or middle-piece, surrounded by very delicate spiral filaments or flanges, of which there usually appear to be three. An irregular, oval, flexible spermatophore is formed.

Eggs.—According to Binney, Gibbons stated that the eggs of *Trigonephrus globulus* were of a very large size.* It is probable, however, that in this sub-family they do not attain such large dimensions as in some genera of the *Acavidae*; for although the embryonic shell is not clearly differentiated from the succeeding whorls, it evidently does not reach the enormous size found in some members of the family.

* Ann. N.Y. Acad. Sci., 1880, i. p. 361.

Such are the chief characters found in those species of *Trigonephrus* and *Dorcasia*, of which it has been possible to examine the anatomy. Whether these features are possessed by *Tulbaghinia* also, it is at present impossible to say, for no specimens of this genus have been available for dissection.

Distribution.—SOUTH-WEST AFRICA, chiefly near the coast and in the neighbourhood of rivers, from Algoa Bay and Montagu in the Cape Province to the Northern borders of Damaraland.

GENUS TRIGONEPHRUS, Pilsbry, 1905.

Proc. Mal. Soc., vi. p. 286.

Shell rather large, elongate- to compressed-globose, perforate, fairly solid, almost unicoloured. Whorls 4–5, rapidly increasing, all but the earliest covered with close faint transverse striae following the lines of growth, usually combined with a considerable amount of malleation, and, in some species, inconstant tracts of close, microscopic, spiral sculpture. Aperture large; peristome interrupted, margins externally thickened, sometimes to a considerable extent backward from the lip, and narrowly reflexed.

Animal differing from *Dorcasia* in the following respects. Foot-sole entire, without any longitudinal grooves. Kidney broader at the anterior end than in *Dorcasia*, with no fold along its right side. Pedal gland more or less embedded in the muscles of the foot. Cerebral ganglia pigmented. Jaw rather broad, and more than 2 mm. long. Radula about twice as long as it is broad; teeth larger than in *Dorcasia*; central and lateral teeth tricuspid; in the marginals the endocone gradually unites with the mesocone, and in the outer teeth the ectocone often disappears, though most of the marginals are bicuspid; bases of central teeth usually a little shorter than the mesocones.

Reproductive system: free oviduct greatly swollen; receptacular duct less than twice the length of the free oviduct; excepting in *T. lucanus*, the receptacular duct does not cross the common duct, and the vas deferens curves round the right side of the free oviduct, is closely bound to the penis, and terminates in a short epiphallus; penis containing rows of prominent rugae, or short papillae, which fuse with one another to form corrugated longitudinal ridges.

Distribution.—SOUTH-WEST AFRICA, for the most part in sandy

scrub near the coast, from Algoa Bay and Montagu, in the Cape Province, to the Southern districts of Damaraland.

Genotype. *T. globulus* (Müller).

In their general anatomy the species of this genus that have been dissected agree very closely with one another. Only in the reproductive organs of *T. lucanus* do we find any marked divergence from the common type. The radula is very constant throughout the genus, the specific differences being slight; and the tricuspid condition of the central and lateral teeth forms, perhaps, the most striking character of *Trigonephrus*. So far as is known, this feature is found in no other genus of the *Acavidae*; and Pilsbry has pointed out that the presence of side-cusps in *Trigonephrus* indicates that it is a relatively primitive member of the family.*

There can be little doubt that in its tricuspid central teeth *Trigonephrus* retains a feature which was possessed by the ancestors of the group, but has been lost by nearly all the other members of the *Acavidae*. It is not so certain, however, that these ancestral forms possessed tricuspid lateral teeth. Pilsbry has justly stated that as a rule "all modifications in the teeth proceed from the median line of the radula outwards towards the edges, the outer marginal teeth being the last to be modified"; and that "a study of the marginal teeth, therefore, gives a clue in many cases to the ancestral condition of a much modified radula."† Now if we examine the marginal teeth of *Trigonephrus*, we find that while the ectocone is, from its first appearance on the outer teeth, a separate cusp, the endocone arises by the bifurcation of the mesocone, with which it is united in the marginal teeth (see especially Pl. IV., fig. 11). It therefore seems not unreasonable to suppose that the endocones on the lateral teeth of *Trigonephrus* may have thus arisen from the mesocones in evolution, and that the ancestral *Acavidae* may have had bicuspid lateral teeth. According to the principles explained when discussing the distribution of the *Acavidae*, the most primitive members of the family should be found, not in South Africa, but in the more remote regions of South America, which are furthest from the centre of evolution. It is therefore specially significant that in the radula of *Strophocheilus rosaceus*, King, from Chili (judging from a specimen, found at Coquimbo, in Professor Gwatkin's magnificent collection), while the central teeth are tricuspid, as in *Trigonephrus*, both the lateral and the marginal teeth are bicuspid, without

* Proc. Mal. Soc., 1905, vi. p. 288.

† Man. of Conch., 1895, ix. p. xiii.

endocones. It seems possible, therefore, that in this form the ancestral type of radula has been retained, while in the other members of the family the lateral teeth have become modified to match the central teeth, beginning with those nearest the middle. In most forms the central teeth have lost their secondary cusps, and the ectocones on the lateral teeth have accordingly disappeared; but in *Trigonephrus* the central teeth have remained tricuspid, and the lateral teeth may have come to resemble them by the inner portions of their bifid mesocones becoming separated to form small endocones similar to the ectocones. When the teeth in the radula are numerous and arranged in nearly straight transverse rows, it is evident that all those towards the centre will have very similar functions, and that the right and left sides of any one of these teeth will have much the same work to do; and we might therefore be surprised if the central and lateral teeth did not tend to become like each other, the cusps of the laterals becoming more symmetrical.

A parallel case occurs among the true *Helices* of Europe. Nearly all of these have bicuspid lateral teeth, though the mesocones are frequently bifid. But in *Helix aperta*, Born, and *H. subaperta*, Ancy, the laterals are tricuspid, as in *Trigonephrus*, the inner portions of the mesocones having separated to form true endocones.

The internal structure of the penis in most of the species reminds one of Wiegmann's figure of the penis of *Papuina vitrea*.*

Some of the shells of *Trigonephrus* have long been a source of trouble to students.

Müller's originals of *T. globulus*, *rosaceus*, and *lucanus* are preserved in the Copenhagen Museum. Drs. Nordmann and Jensen of that Museum have kindly compared specimens, furnished by myself, of the shells which usually pass under the above names in British collections with the originals, and have reported that *globulus* and *lucanus*, as generally known, are quite correctly identified, and that the *rosaceus*, though not exactly agreeing with the Type, is undoubtedly conspecific.

This preliminary matter being determined, it is possible to prescribe means whereby the more puzzling forms may be distinguished.

The actual shape and size of the shell, and, to a less extent, the coloration and sculpture, may vary greatly in the same species; but, in a large array of material, I have failed, so far, to disprove the

* Abh. Senckenb. Naturf. Ges., Frankfurt, 1898, xxiv. Pl. XXXI, f. 8.

constancy of two features, namely, the colour of the peristome and the relative shape of the aperture.

As regards the former, though exceptions may of course exist, I have never seen *T. lucanus* or *namaquensis* with any but a white peristome, nor good specimens of the remaining species, *globulus*, *gypsinus*, *rosaceus*, *porphyrostoma* and *ambiguosus*, with other than a deeply coloured one.

With regard to the second point, we have what may be roughly divided into two forms of aperture, one drooping, the other outstanding. In *T. globulus* the upper end of the outer lip is comparatively further away from the columella than in *rosaceus*, so that it forms with the body whorl an obtuse external angle of about 125° , and imparts to the aperture a drooping appearance. In *rosaceus* the ends of the aperture appear to be comparatively nearer together, the outer lip consequently leaving the body whorl at a much sharper angle of about 105° , so that the aperture appears to be flatter and more outstanding.

T. namaquensis has the drooping *globulus* aperture, while *T. porphyrostoma* and *gypsinus* have, more nearly, that of *T. rosaceus*. *T. lucanus* and *ambiguosus* form, of course, a separate group.

Certain species of *Trigonephrus* exhibit, under a strong lens, irregular patches of granular, or of a kind of close, incised, spiral sculpture. These are usually present where there is least malleation, but are of very partial and uncertain occurrence, and cannot, in my opinion, be regarded as constant factors in determining the specific position of a shell.

TRIGONEPHRUS GLOBULUS (Müller).

(Pl. II, f. 1, 2. Pl. IV, f. 1, 7, 9, 17, 27. Pl. V, f. 1, 9.)

1774 *Helix globulus*, Müll., Verm. ii. p. 68. *D.*

Shell large, globose, umbilicate, solid, translucent, early whorls red-lilac above, later violet-blue, with occasional whitish mottling and small dark spots, and a narrow infra-sutural white band; under-part paler, almost white; peristome, callus, and interior reddish purple. Spire somewhat produced, apex rounded. Whorls 5, rounded, regularly and rapidly increasing, the apical smooth, remainder covered with very fine, close, transverse striae, with irregular malleation on the upper part of the later whorls and occasional traces of microscopic spiral sculpture. Suture well defined, subcrenulate. Aperture quadrate-ovate; peristome thick-

ened and somewhat reflexed, ends joined by a thin callus; outer lip making with the body whorl an angle of about 125° , and imparting a drooping appearance to the aperture. Columella erect, slightly concave, margin reflexed, partially concealing the narrow umbilicus.

Dimensions of a typical specimen from Hout Bay: Alt. max. 32.0; diam. 30.3; apert. 19.0×15.7 mm.; ends of peristome 15 mm. apart.

Animal of a single full-grown specimen from Milnerton, the shell of which measured about 32 mm. in altitude.—*

Colour drab, probably due to long immersion in alcohol; roof of mantle-cavity unpigmented. Body-lobes indistinguishable, owing to the bad preservation of the specimen. Principal pulmonary vein giving off more numerous transverse branches than usual (see Pl. IV., fig. 1, which also shows the form of the kidney, etc.).

Cerebral ganglia covered with grey connective tissue. Jaw 2.9 mm. long, more curved than usual, reddish brown and of moderate thickness, with scarcely a trace of a median projection (Pl. IV., fig. 17). Radula $6\frac{1}{2} \times 3\frac{1}{4}$ mm.; transverse rows of teeth almost straight; teeth relatively larger than in the allied species; centrals very similar to the laterals; outer marginals longer and narrower than usual, with single well-developed cusps (see Pl. IV., fig. 9); formula $(45 + 1 + 48) \times 115$. Radula-sac projecting beyond the buccal mass (Pl. IV., fig. 7).

Reproductive system (Pl. V., fig. 1): hermaphrodite duct slender, with broader convolutions than in the other species; vesicula seminalis club-shaped, rather thick; receptaculum seminis oval; anterior third of receptacular duct swollen; vagina short, somewhat swollen; vas deferens curving a little further round the free oviduct than usual; epiphallus longer than in the other species, being nearly one-third of the length of the penis; posterior part of penis curved; rugae on the longitudinal folds inside the penis diamond-shaped, being much narrower than in the remaining species (Pl. IV., fig. 27).

Hab. CAPE PROVINCE. Generally distributed along the coast from Algoa Bay (*vide* Layard) to St. Helena Bay; Robben and Dassen Islands.

Type in Copenhagen Museum.

A large sinistral specimen, collected by Craven on Robben Island, is in the British Museum.

The late E. L. Layard, through whose hands passed most of the

* In order to avoid unnecessary repetition in describing the animals of the species, only those parts will be mentioned which have been found to differ in the various forms.

material sent home by the earlier collectors, left some valuable manuscript notes on the distribution of the *Trigonephri*, which, by Mr. Ponsonby's courtesy, I am enabled to publish. The record of *T. globulus* on Green Point Common is remarkable, as the species is now unknown there, having been completely ousted by the introduced *H. pisana*, Müll.

It will be noticed that Layard wrote in the days when only three species had been described, and he attributed every form to one or other of them, but this detracts but little from the interest of his notes, to which I shall have course to refer later.

"*Helix globulus*, Müll.—Various forms of this very variable shell are found on all sandy plains along the seaboard from Cape Agulhas to Walfisch Bay and Namaqualand. During the dry summer season they lie concealed, buried to a considerable depth in the sand, but on the fall of heavy rain they emerge from their retreats in thousands. I shall never forget my first sight of the living shells. I had found the sandy plain near Cape Town, known as Green Point, covered with the dead, bleached shells, but not a live one could I procure. Some friends even hinted at their being fossil and extinct, but I asserted they were too fresh-looking for that, and waited for the rains. They came, and I sallied out in the downpour, calling on an enthusiastic friend, C. A. F., to accompany me. On getting on to the Common, past the Battery, we found the surface of the ground literally heaving with the swarms coming up! They were everywhere! We gathered our handkerchiefs full, and as they emit a most copious, clear slime, we were soon covered with the sand which adhered to it and wet from head to foot with the pitiless downpour, and presented a draggle-tailed spectacle; but we agreed that the sight of tens of thousands, emerging from their long sleep, repaid us for all our dirt and discomfort.

"The specimens found near Cape Town, Kalk Bay and the Cape Flats may be taken as of fair medium size. They are about 31×29 mm. On Robben Island, a sandpatch in the mouth of Table Bay, there is a fine large variety, similar in colour, $38\frac{1}{2} \times 40$ mm. In Nord Hoek, not far from Kalk Bay, I took a small variety, fully formed shells varying from $25\frac{1}{2} \times 19\frac{1}{2}$ to 15×15 mm., shells purely white. In the George District there is a small variety, 19×19 mm., with a pale purple, or puce-coloured mouth. Another variety, probably from Algoa Bay, rather larger, $27\frac{1}{2} \times 25\frac{1}{2}$ mm., is much darker in the mouth, and the apex is also dark bluish purple.

"These seem to lead into the large solid shell, with the broadly recurved, heavy, purple lip, from Namaqualand, named *rosacea* by

Müller. The transition is through a shell resembling the Robben Island form, but with a rose-coloured lip and a general bluish-purple tint throughout, also found in Namaqualand. There are two forms of this, one globular, the other elongated, $44 \times 38\frac{1}{2}$ mm.

"There is yet another variety from Namaqualand, a small, stout, glossy form, 19.5×17 mm., of a pinkish colour, of which I have only seen two examples.

"I am ignorant of the exact localities whence these varieties were severally procured; they were brought out by the late James Chapman, who also procured a solid white variety in Ovampoland.

"I suspect the coarse, solid shell of the variety called *rosacea* must be meant as a protection against the great heat and drought of the locality where found.

"The small purple-mouthed variety from George runs into one of the varieties of *Helix lucana*, Müll., from the same locality."

The shell selected for description is of average size, from Hout Bay, Cape Peninsula, and the animal is taken from a similar specimen, which was broken for anatomical purposes. This solid, bluish-purple form is that which is now found alive all over the extreme south-western corner of the Cape Province, the largest Peninsula example which I have measured being: alt. max. 37.6; diam. 33; apert. 23.4×17.5 mm.; and the smallest living one: alt. max. 25.7; diam. 25; apert. 15.7×12.2 mm.

Whether this form is of comparatively recent growth from a smaller one, I cannot say; but in an old shell mound at Milner-ton are the subfossil remains of a smaller race, measuring about $22\frac{1}{2} \times 21\frac{1}{2}$ mm., and a somewhat similar variety is mentioned by Layard as existing, in bleached condition, at Nord Hoek. Almost the same is now found alive on Dassen Island (Pl. II., fig. 2), but the shell is thinner and apparently of a redder hue, with a browner peristome than the normal form.

This leads up to a very distinct local race, inhabiting the mainland at St. Helena Bay. In it, the shell nearly regains the size of typical *globulus*, which it also resembles in general shape and drooping aperture, but it is of thinner texture, rosy brown in colour, and the surface is more glossy and far more malleate. The four specimens known to me measure:—

Alt. max.	29.8;	diam.	28.5;	apert.	17.3×14.1	mm.
„	27.0;	„	28.7;	„	16.9×13.3	„
„	27.0;	„	26.9;	„	15.2×12.2	„
„	26.2;	„	25.1;	„	13.9×11.1	„

This is the most northerly race of the true *globulus* which I have yet seen, for on reaching Namaland the drooping *globulus* aperture is transferred to the thin, white-lipped *T. namaquensis*, and the solid shells, which might otherwise be considered almost inseparable from *globulus*, have the projecting aperture of *T. rosaceus*.

The peristome is sometimes thickened a little squarely, but this feature is not usually nearly so marked as in *rosaceus* or *porphyrostoma*.

The anatomy of this species was described and figured by Pilsbry in 1905*. Six years earlier Moss and Webb published a description and figure of the reproductive organs of a specimen from Robben Island†; while so long ago as 1880 Binney described the jaw and radula and figured some of the teeth‡. Pilsbry and Moss and Webb state that the jaw is smooth, which does not agree with the observations of the present writer: Binney merely says that it is without anterior ribs. Moss and Webb's figure does not show the swollen anterior end of the receptacular duct, but this is shown in Pilsbry's figures.

It will be seen by comparing fig. 9 with figs. 10 and 11 on Pl. IV. that, in the specimens examined, the teeth of the radula of this species are actually a little larger than those of *T. rosaceus* and *T. porphyrostoma*, notwithstanding that its shell, jaw, and reproductive organs are so much smaller. It is therefore not surprising to find that the number of teeth in each transverse row in *T. globulus* is usually less than in the other forms. Binney gives the number as about 81, Pilsbry as about 90, while in the specimen described above it is about 94.

Apart from the radula, perhaps the most distinctive anatomical characters of the present species are the jaw, the long epiphallus, and the internal structure of the penis. Further information is desirable about the external features of the animal.

TRIGONEPHRUS GYPSINUS (Melv. & Pons.).

(Text-fig. 2 and Pl. II, f. 3.)

1891 *Helix (Dorcasia) gypsina*, M. & P., A.M.N.H. viii. p. 238. D.

Shell elongate-globose, umbilicate, fairly solid, translucent, type bleached pale buff, peristome and callus apparently faded brown. Spire rather produced, apex rounded. Whorls 4, very

* Proc. Mal. Soc., vi. p. 286. Pl. XIII, f. 6-9, pl. XIV, f. 13, 15.

† Proc. Mal. Soc., iii. p. 264.

‡ Ann. N.Y. Acad. Sci., i. p. 361. Pl. XIV, f. K.

convex, rapidly increasing, sculpture very worn, apparently originally consisting of fine transverse striation, with faint malleation on the later whorls. Suture deep, simple. Aperture rather small, quadrately rounded; peristome thickened and slightly reflexed, the ends joined by a distinct callus, the outer lip making with the body whorl an angle of 105° ; columella erect, margin strongly reflexed, partly concealing the narrow perforation.

Dimensions of Type: Alt. max. 24.5; diam. 20.2; apert. 13×10.9 mm.; ends of peristome 8.8 mm. apart.

Animal of two full-grown specimens from Wilde Paards Hoek.—

Colour (in alcohol): head and foot tinged with grey, the hind end of the foot being the darkest, mantle-edge grey to the left of the respiratory opening, but reddish and considerably swollen on the right side; roof of mantle-cavity unpigmented; upper whorls light yellow above the suture. Left body-lobe divided into two portions, which are connected by a fold or ridge; left division about as broad as the right, but lower. Pulmonary veins: a second large branch of the pericardial vein arises close to the origin of the first branch (text-fig. 2, A).

Cerebral ganglia covered with grey connective tissue. Jaw 2.9 mm. long, rather thin, light brown; resembling in form those of the three following species (cf. Pl. IV., figs. 18–20). Radula of the same specimen (the shell of which measured 24×24 mm.) $6\frac{1}{3} \times 3\frac{1}{4}$ mm.; transverse rows of teeth almost straight; centrals very similar to the laterals (text-fig. 2, B); formula, $(53+1+53) \times 133$. Radula-sac projecting beyond the buccal mass.

Reproductive system (text-fig. 2, C): hermaphrodite duct long, swollen, and much convoluted; vesicula seminalis unusually long, rather broad distally but tapering proximally; receptaculum seminis oval and unusually large; receptacular duct somewhat swollen at its anterior end; vagina short, thicker behind than in front; epiphallus very short; penis curved at the hind end; rugae on the longitudinal folds inside the penis much broader than long, as in the three following species (cf. Pl. IV., fig. 28).

Hab. LITTLE NAMALAND.

Type in British Museum.

This species having been founded on a bleached, subfossil shell, the original description is somewhat misleading. Some doubt, moreover, attaches to the correctness of the original locality, the fact that it was given as Springbok having led to a quite distinct form, *T. namaquensis*, var. *procerus*, being confounded with *gypsinus*.

A small series, collected by Dr. Rogers at Wilde Paards Hoek,

Little Namaland, has just come to hand, which appears to be quite conspecific with the subfossil Type, and as it includes two spirit-specimens, in excellent preservation, it has enabled me to present particulars of the animal.

In these shells the spire is comparatively less produced, their

TEXT-FIGURE 2.

Anatomy of *Trigonephrus gypsinus* (M. & P.).

- A. Pallial organs.
- B. Teeth from the radula, $\times 200$.
- C. Reproductive organs, $\times 3$.

form being globose, rather than elongate-globose, but they agree with the Type in its two main characteristics, the very convex whorls and peculiarly small, rounded aperture. The colour is uniform pinkish drab, except the peristome and thin callus, which are pale rosy brown. The sculpture, on all but the $1\frac{1}{2}$ apical whorls, consists of extremely faint, close, transverse striation, and shows considerable malleation, especially on the upper portion of the last $1\frac{1}{2}$ whorls.

The dimensions vary from :—

Alt. max. 24.4 ; diam. 24.5 ; apert. 13.6×10.1 mm.

to „ 22.3 ; „ 20.2 ; „ 11.5×9.2 mm.

I have also seen a very bleached example, apparently referable to this species, from Kaitop.

Probably *T. gypsinus* is a relatively primitive member of the genus. In its internal anatomy it possesses very few distinctive characters which are not shared by one or other of the remaining species, but in no other form do we find all these features combined. Perhaps it is most nearly related to *T. rosaceus*, but it differs from that species in its short vagina, swollen hermaphrodite duct, and a few other characters. From *T. globulus* it may be easily distinguished by its jaw, epiphallus, and penis ; while the coloration of the animal at once separates it from *T. namaquensis*, which it somewhat resembles in the lobes on its mantle-edge and in its internal anatomy. The number of transverse rows of teeth in the radula of this species is larger than in any other known member of the genus, and in this respect *T. gypsinus* resembles *Dorcasia*.

The animals were received too late for illustrations of their anatomy to be included in Plates IV. and V., but the accompanying text-figure shows some of their more important characters.

TRIGONEPHRUS ROSACEUS (Müller).

(Pl. II, f. 4, 5. Pl. IV, f. 10, 18. Pl. V, f. 2.)

1774 *Helix rosacea*, Müll., Verm. ii. p. 76. D.

Shell large, globose, umbilicate, fairly solid, translucent, shading from pinkish buff on the earlier, to bluish violet on the last whorl ; interior nacreous blue, aperture and paries purple-brown. Spire but little produced ; apex rounded. Whorls 5, very convex, rapidly increasing, all but the apical covered with close, straight, regular, transverse striae, and showing occasional traces of close, faint, spiral sculpture ; upper surface strongly malleate. Suture deep, subcrenulate. Aperture lunate ; peristome thickened and reflexed, ends joined by a very slight callus ; outer lip making with the body-whorl an angle of 105° . Columella obliquely concave, margin half concealing the deep umbilicus.

Dimensions of a fairly typical specimen from between the Holgat and Orange Rivers : Alt. max. 39.2 ; diam. 42.0 ; apert. 24.5×20.5 mm. ; ends of peristome 16.5 mm. apart.

Animal of the same specimen.—

Colour (in alcohol) light grey, darkest towards the hind end of

the foot; mantle-edge a darker shade of grey; roof of mantle-cavity unpigmented. Body-lobes very small, the two divisions of the left lobe being represented by a small low ridge near the respiratory opening, and a little triangular flap on the left side of the animal. Pulmonary veins similar to those of the next species, the first branch of the pericardial vein arising nearer to the main pulmonary vein than in *T. globulus* (cf. Pl. IV., fig. 2).

Cerebral ganglia covered with pale grey connective tissue. Jaw 3.65 mm. long, thick, dark brown (Pl. IV., fig. 18). Radula $7\frac{3}{4} \times 4\frac{1}{4}$ mm.; transverse rows of teeth nearly straight; centrals with rather broad bases and narrow median cusps (Pl. IV., fig. 10); formula, $(62 + 1 + 66) \times 124$. Radula-sac projecting beyond the buccal mass.

Reproductive system (Pl. V., fig. 2): hermaphrodite duct slender, closely convoluted; vesicula seminalis club-shaped, rather thick, as in *T. globulus*; receptaculum seminis somewhat elongate; receptacular duct only very slightly swollen at the anterior end; vagina long and rather narrow; vas deferens slightly convoluted for only a very short distance next to the epiphallus, instead of for nearly half the length of the penis, as in the other species; epiphallus very short; penis very abruptly curved near the hind end; rugae on the longitudinal folds inside the penis much broader than long, as in *T. gypsinus* and the two following species (cf. Pl. IV., fig. 28).

Hab. LITTLE NAMALAND. Between the Holgat and Orange Rivers; Koingnaas (Rogers). Port Nolloth; Anenous (Day).

Type in Copenhagen Museum.

The shell figured is the only one known to have been taken in live condition. Though a good average example of the species, it does not quite equal Müller's Type in size or exactly resemble it in all detail. Dr. Jensen writes that the Type, an *unicum*, is an old, somewhat worn specimen, upon which the sculpture only appears locally, and the spire is a little obliquely deformed; it has a rather broader mouth and more pronounced wrinkled transverse sculpture than the figured shell, but there is no doubt that the latter is to be referred to *H. rosacea*, Müll.

This species appears to be very variable in size, while the comparative height of spire and strength of sculpture are by no means constant; in some examples the malleation is so pronounced as almost to efface the striation, while in others there is little malleation and the striation is far more clear. In all specimens which I have seen, however, the shell is globose in shape, as compared with the more elongate *T. porphyrostoma*, and the

sculpture is much finer, never approaching the coarse, rib-like striation of the last-named species.

The aperture, as before mentioned, projects more out to the side than that of *globulus*, and affords a ready means of distinction. The margins, moreover, are sometimes thickened backwards for as much as $3\frac{1}{2}$ mm., and then squarely grooved, rather than reflexed; but this feature is quite inconstant, even among specimens from the same locality.

The large form of *T. rosaceus* seems to be pretty generally distributed in the neighbourhood of the Lower Orange River, though I have no definite localities for it except Port Nolloth. A smaller form, which from its sculpture and aperture probably represents a local race of the same species, is depicted on Pl. II., fig. 5. It has only come to hand so far in bleached condition, from Anenous and Koingnaas.

Judging from the single specimen dissected, the reproductive organs of *T. rosaceus* differ from those of both the preceding forms in the long vagina, and in the very small extent to which the vas deferens is convoluted. From *T. globulus* this species also appears to differ in its jaw, receptacular duct, epiphallus, and penis; and from *T. gypsinus* in its mantle-edge, hermaphrodite duct, and vesicula seminalis.

TRIGONEPHRUS PORPHYROSTOMA (Melv. & Pons.).

(Pl. II, f. 6. Pl. IV, f. 2, 11, 19, 25, 28. Pl. V, f. 3. Text-fig. 1, A, B.)

1891 *Helix* (*Dorcasia*) *porphyrostoma*, M. & P., A.M.N.H. viii. p. 238. *D.*

Shell large, slightly elongate-globose, deeply rimate, solid, just translucent, shading in colour from pale pink on the earlier, to bluish grey on the later whorls; peristome and interior purple-brown. Spire somewhat produced, very nearly as long as the aperture; apex rounded. Whorls $5\frac{1}{2}$, convex, rapidly increasing, all but the first two faintly and irregularly malleate above, and covered with straight transverse striæ, which become coarse and more distant with the growth of the shell, and assume a rib-like appearance towards the aperture. Suture deep, subcrenulate. Aperture quadrate; peristome reflexed and much thickened, ends joined by a distinct callus; outer lip making with the body-whorl an angle of nearly 120° . Columella erect, margin broadly reflexed, almost concealing the narrow perforation.

Dimensions of a typical specimen from between the Holgat and

Orange Rivers: Alt. max. 41·5; diam. 39·7; apert. $23·5 \times 20·4$ mm.; ends of peristome 18·3 mm. apart.

Animal of full-grown specimens from the same locality, the shells of which measured about 45 mm. in altitude.—

Colour (in alcohol) grey, the hind end of the foot, the sole and the mantle-edge being the darkest; roof of mantle cavity unpigmented. Left body-lobe irregularly swollen, its two divisions united by a fold. Pulmonary veins similar to those of the last species, the first branch of the pericardial vein arising nearer to the main pulmonary vein than in *T. globulus* (Pl. IV., fig. 2).

Cerebral ganglia covered with grey connective tissue. Jaw 3·7 mm. long, thick, dark brown (Pl. IV., fig. 19). Radula $7\frac{1}{2} \times 4\frac{1}{4}$ mm., transverse rows of teeth almost straight; centrals narrow, with rather inconspicuous side-cusps; outer marginals unusually broad; mesocones prominently bifid on a larger number of teeth than in the other species (Pl. IV., fig. 11); formula of one specimen $(61+1+62) \times 124$, of another $(63+1+62) \times 128$. Radula-sac not projecting beyond the hind end of the buccal mass.

Reproductive system (Pl. V., fig. 3): hermaphrodite duct slender, closely convoluted; vesicula seminalis rather small, swollen at the end but very narrow proximally; receptaculum seminis oval; receptacular duct not swollen; vagina long and rather narrow; epiphallus very short; penis abruptly curved at the hind end; rugae on the longitudinal folds inside the penis much broader than long (Pl. IV., fig. 28).

Hab. LITTLE NAMALAND. Port Nolloth; T'Kaigas; between the Holgat and Orange Rivers; Koingnaas.

GREAT NAMALAND. Ghous; Angra Pequena.

Type in British Museum.

The shell is separable from that of *T. rosaceus* by its more elongate spire and coarser, rib-like striation on the last whorl. The peristome almost invariably shows the square external thickening, which is an irregular feature in the preceding species.

Both in the general appearance of the animal, however, and in most of the details of its internal anatomy, *T. porphyrostoma* closely resembles *T. rosaceus*, and it is evident that these two forms are very nearly allied; yet the radula of *porphyrostoma* differs considerably from that of *rosaceus*, especially in the form of the central teeth, and slight differences seem to be present in some of the soft parts, such as the vesicula seminalis. Moreover, as the specimens examined of both species were found in the same locality, these differences may be regarded as having a greater systematic importance than if the

specimens had been collected in different districts. The anatomical evidence seems, therefore, to support the view that *T. porphyrostoma* and *T. rosaceus* are distinct, though closely related, species.

TRIGONEPHRUS NAMAQUENSIS (Melv. & Pons.).

(Pl. II, f. 7. Pl. IV, f. 3, 8, 12, 20. Pl. V, f. 4.)

1891 *Helix* (*Dorcasia*) *namaquensis*, M. & P., A.M.N.H. viii. p. 237. D.

Shell slightly elongate-globose, narrowly perforate, thin, smooth, semitransparent, uniform yellow-brown, interior nacreous, peristome white and glossy. Spire moderately produced, about three-fifths the length of the aperture; apex very blunt. Whorls $4\frac{1}{2}$, rounded, rapidly increasing, all but the apical covered with very faint, close, regular, straight, transverse striae, and rather faint, irregular malleation, with occasional traces of close, microscopic, spiral sculpture. Suture simple, well defined. Aperture ovate; peristome narrowly reflexed, outer lip making with body-whorl an angle of about 130° ; callus faint. Columella erect, slightly concave, margin rather broadly reflexed, almost concealing the narrow perforation.

Dimensions of a specimen from "South Africa": Alt. max. 26.3; diam. 24.9; apert. 16.1×13.4 mm.; ends of peristome 11.7 mm. apart.

Animal of the above and another specimen from the same locality, one incomplete and the other immature.—

Colour (in alcohol): foot and mantle-edge pale yellowish buff; head tinged with grey on the top; roof of mantle-cavity conspicuously mottled with black, the mottling extending back over the pericardium, but being most concentrated just behind the mantle-edge and near the rectum; numerous irregular black patches occur on the outer surface of the roof of the cavity, while minute black specks are sparsely scattered over its inner surface. Left body-lobe divided into two portions connected by a very slight fold or ridge; left division much smaller than the right. Pulmonary veins: two chief efferent vessels bifurcating not very far from their origin (Pl. IV., fig. 3).

Cerebral ganglia covered with dark grey connective tissue. Jaw of the full-grown specimen 2.75 mm. long, thin, yellow-brown (Pl. IV., fig. 20). Radula 6×3 mm., transverse rows of teeth nearly straight; centrals with rather narrow median cusps (Pl. IV., fig. 12); formula $(53 + 1 + 55) \times 114$. Radula-sac not projecting beyond the hind end of the buccal mass in the full-grown specimen.

Reproductive system (Pl. V., fig. 4): hermaphrodite duct and vesicula seminalis absent from the mature specimen, having been left in the shell with the posterior division of the liver when the animal was extracted; receptaculum seminis rather large, tapering posteriorly; receptacular duct scarcely thickened towards the anterior end; vagina short, swollen posteriorly; epiphallus very short; penis somewhat curved at the hind end, swollen near the genital opening, the vas deferens being more deeply embedded than usual in the wall of the swollen part; rugae on the longitudinal folds inside the penis much broader than long, as in the last three species (cf. Pl. IV., fig. 28).

Hab. LITTLE NAMALAND. Quaggafontein; Ookiep; Wilde Paards Hoek; hills west of Groen Kloof (Rogers); Muishond; Meskiep; Kamaggas (Schultze).

Type in British Museum.

This uncommon but rather widely distributed species is easily recognizable by its thin brown shell and white peristome.

The colouring of the animal also distinguishes it from all the preceding species. Possibly the concentration of the dark pigment into black patches and spots on the roof of the mantle-cavity is connected with the thinness of the shell, which would allow more light to penetrate to the lung than in the case of forms with thicker shells. In its internal anatomy *T. namaquensis* closely resembles *T. gypsinus*; but it differs from that species, as well as from the other members of the genus, in the enlarged base of the penis.

TRIGONEPHRUS NAMAQUENSIS (Melv. & Pons.), var. PROCERUS, nov.,
1915.

(Plate II, f. 8, 9.)

1912 *Trigonephrus gypsinus*, M. & P. (*pars*), Conn., Ann. S.A. Mus. xi. p. 155.

Shell comparatively small, ovate, perforate, thin, nearly transparent, uniform pale corneous except the umbilical region and peristome, which are white; interior nacreous. Spire produced, about two-thirds the length of the aperture; apex obtusely rounded. Whorls $4\frac{1}{2}$, inflated, rapidly increasing, covered, after the first two, with extremely faint, regular, close, transverse striae, and faint, irregular pitting or malleation, hardly visible without a lens, which imparts to the surface a slight appearance of spiral sculpture. Suture deep, simple. Aperture quadrate-ovate; peristome slightly reflexed; outer lip making with the body-whorl an obtuse angle of

120°, and giving to the aperture the drooping appearance of *T. globulus*; callus none. Columella erect, with conspicuous wrinkles of growth on the broad upper margin, which is strongly reflexed, almost concealing the deep, narrow perforation.

Alt. max. 22·8; diam. 19·0; apert. $12·7 \times 9·0$ mm.; ends of peristome 6·5 mm. apart.

Animal unknown.

Hab. LITTLE NAMALAND. Ookiep (Lightfoot; Day; Rogers). Buffels River (Rogers).

Type in coll. Ponsonby.

The shell selected as Type is the only good specimen I have seen. Its finding-place is uncertain, but bleached shells, exactly agreeing with it in form and substance, have been brought on more than one occasion from the neighbourhood of Ookiep, whence the Type also was probably derived.

Another white-mouthed race, very similar in form to the above, but of thicker substance, is found further south at Clanwilliam and apparently also at Kangnas and Areb, which may bear, for the present, the same varietal name, although I think that when live specimens are discovered they may be found to constitute a distinct species. Intermediates between these unusually elongated races and the typical form of *namaquensis* also occur and establish a connection between them, which would hardly be apparent if the extremes alone were considered. A peculiarly small example from Clanwilliam is shown on Plate II., fig. 9.

TRIGONEPHRUS LUCANUS (Müller).

(Pl. II, f. 10. Pl. IV, f. 4, 13, 21, 29. Pl. V, f. 5, 10.)

1774 *Helix lucana*, Müll., Verm. ii. p. 75. *D.*

Shell rather large, subglobose, deeply umbilicate, rather thin, translucent, chestnut-brown, paler underneath, with a narrow infra-sutural white line; peristome white; interior pale brown. Spire moderately elevated, apex blunt. Whorls 5, rounded, rapidly increasing, all except the first $1\frac{1}{2}$ covered with very close, faint, regular transverse striae, extending more faintly into the umbilicus, and faint malleation, more pronounced towards the aperture. Suture rather shallow and crenulate. Aperture truncate-ovate; peristome slightly thickened and reflexed, ends joined by a faint callus. Umbilicus narrow but deep, extending to the apex.

Dimensions of a typical specimen from Cape Point, which agrees

with Müller's originals: Diam. maj. 29·2, min. 23·2; alt. max. 20·0; apert. $16·7 \times 13·5$ mm.; ends of peristome 7 mm. apart.

Animal of specimens from Montagu, the shells of which measured about 24 mm. in diameter, and a single, larger, but immature specimen from Kommetje, which had a white shell.—

Colour (in alcohol): foot and mantle-edge pale; top of head and neck tinged with grey; roof of mantle-cavity streaked and spotted with dark grey, the pigment extending back over the pericardium, but being most abundant along the three principal blood-vessels and near the rectum; the mottling is coarser in the Kommetje specimen than in those from Montagu. Left body-lobe consisting of two divisions connected by a fold or ridge, the left division being broad but very low, scarcely projecting further than the connecting fold. Pulmonary veins showing a simple generalized arrangement. The fold, which runs along the side of the rectum and projects into the mantle-cavity next to the band of modified epithelium, is well developed in this species and somewhat sinuous (Pl. IV., fig. 4).

Cerebral ganglia covered with pale grey connective tissue. Jaw (of the Kommetje specimen) 2·55 mm. long, rather thin, reddish brown along the lower edge; ends squarer and edges more nearly parallel than in the preceding species. In a Montagu specimen the jaw is similar, but smaller. Radula (of a Montagu specimen) $5 \times 2\frac{1}{2}$ mm.; transverse rows of teeth nearly straight; centrals similar to the laterals, but a little smaller (Pl. IV., fig. 13); formula $(43 + 1 + 43) \times 114$. In the Kommetje specimen the radula measures $6\frac{1}{2} \times 2\frac{1}{2}$ mm., the teeth are larger, and the formula is $(35 + 1 + 36) \times 113$. Radula-sac projecting beyond the buccal mass.

Reproductive system (Pl. V., fig. 5): hermaphrodite duct swollen and much convoluted; vesicula seminalis rather long, curved, somewhat swollen distally but tapering proximally; receptaculum seminis oval, rather large; receptacular duct crossing the anterior end of the common duct, shorter than usual, and rather thick; vagina long; vas deferens keeping to the left of the female duct, not attached to the side of the penis; epiphallus absent; penis very long, curved and contorted, the bends occupying different positions in different specimens; rugae on the longitudinal folds inside the penis larger but relatively flatter than in the other species, each crossed by a narrow white ridge (Pl. IV., fig. 29).

Hab. South-western districts of the CAPE PROVINCE. Montagu; Bredasdorp; Avontuur; Hermanus; Rabiesberg, Worcester Div.; Cape Peninsula, from Kalk Bay and Hout Bay to Cape Point.

Type in Copenhagen Museum.

E. R. Sykes has chronicled the existence of a sinistral specimen.

Layard's note on this species runs:—

“*Helix lucana*, Müll.—Another variable and rather widely distributed species, but as yet I have not procured it beyond the limits of the Colony, and in it, chiefly along the Southern seaboard.

“The brown variety, with white band along the suture, is found pretty abundantly about Kalk Bay, in the sand under bushes. A smaller variety, with a brownish purple mouth, is found in the George District; a small variety (diam. 17, alt. 13 mm.) with a white mouth, is not uncommon at Bredasdorp, while a large white form (diam. 32; alt. 25½ mm.) exists at Mossel Bay.”

The first of the above forms is, of course, the typical *lucanus*, and the last must be referable to bleached specimens of *ambiguosus*. The other two are more open to doubt, as I have been unable to trace an authentic example from either of the localities mentioned, but it is reasonable to infer that the form from the George District may be *T. ambiguosus*, var. *compactus*, described hereafter; and that from Bredasdorp, the doubtful species No. 3 on p. 176.

T. lucanus has possibly undergone a slight diminution in size during recent times, for in a subfossil set, collected by J. S. Gibbons at Kalk Bay, are solid, coarsely malleated examples attaining such dimensions as:—

Diam. maj. 38·6, min. 31·0; alt. max. 29·5; apert. 21·1 × 14·9 mm.
and ,, 32·4, ,, 25·5; ,, 22·0; ,, 15·5 × 13·7 ,,

but, in other respects, not varietally separable from Type. The smaller of these shells is remarkable, in that its thick, white callus helps to make a practically continuous peristome, it being almost impossible to mark where the latter ends and the callus begins.

I have collected at Kommetje a white-shelled mutation of *lucanus*, agreeing with the normal form in other respects; the shells found inland at Montagu are slightly smaller and thinner than the coastal race, but cannot be considered even varietally distinct.

While in its radula and in most of its other organs *T. lucanus* agrees closely with those species which have already been described, in its depressed shell and in some features of its reproductive system it departs considerably from the preceding forms, and bears a slight superficial resemblance to the genus *Dorcasia*. The complete detachment of the vas deferens from the side of the penis has doubtless been brought about by the extraordinary

increase in length of the latter organ. Perhaps *T. lucanus* might be regarded as one of the least primitive members of the genus.

TRIGONEPHRUS AMBIGUOSUS (Férussac).

(Pl. II, f. 11).

1821 *Helix* (*Helicella*) *ambigua*s, Fér., Tabl. Syst. Moll. pt. 3. p. 47. *L.*

1848 *Helix lucana*, Müll., var. β , *peristomate aurantiaco*, Pfr., Mon. Hel. viv. i. p. 332.

1850 *Helix lucana*, Müll. (*ambigua*s, Fér.), Desh., Hist. Nat. Moll. pl. X B, f. 3-5. *F.*

1910 *Dorcasia ponsonbyi*, Fulton, A.M.N.H. vi. p. 212. *D.*

Shell rather large, depressed-globose, umbilicate, of moderate thickness, translucent, bright corneous above, much paler, shading to grey, beneath; peristome and callus bright orange-brown. Spire but little raised, apex sub-mamillate, bluntly rounded. Whorls $4\frac{1}{2}$, rounded, rapidly increasing, the first $1\frac{1}{2}$ smooth, remainder covered with close, faint, curved striae, becoming rather fainter beneath, with little malleation, but with tracts of microscopic granular sculpture, which is most apparent on the upper portion of the last whorl. Suture simple, shallow. Aperture truncate-ovate; peristome narrowly reflexed and a little thickened, ends joined by a thin callus. Umbilicus deep, but narrow and a little strangulate.

Dimensions of a cotype of *ponsonbyi* from Mossel Bay, in my collection: Diam. maj. 28.3, min. 23.1; alt. max. 15.8; apert. 15.7×11.7 mm.; ends of peristome 7.7 mm. apart.

Animal unknown.

Hab. CAPE OF GOOD HOPE. Le pays des Hottentots (Férussac); Mossel Bay (Gibbons); Vleesch Bay (Power).

Type of *ambigua*s, *ubi*? that of *ponsonbyi* in British Museum.

Férussac first published the name *ambigua*s among a number of other uncharacterized species, but gave an acceptable locality. Deshayes' conception of the species as *lucanus* is erroneous, but as he expressly states, in the explanation of his plate, that the shell thereon figured as *lucanus* is *ambigua*s, Fér., the latter name is clearly established. The figure in question is a very good one of *Dorcasia ponsonbyi*, Fulton, and this name must, therefore, be relegated to synonymy.

The comparative breadth of the last whorl varies greatly in this species. In most examples it expands considerably towards

the aperture, but in some much more so than in others, and this expansion influences the shape of the umbilicus, which becomes more crooked and strangled in proportion to the amount of expansion. This point, together with the more flattened shell and coloured peristome, serves to distinguish *ambiguosus* at a glance from *lucanus*, in which none of these characters appear. Fulton mentions the microscopic granular sculpture on the last whorl as being of specific value in his description of *ponsonbyi*. In the examples which I have seen, this feature, though usually present, does not appear to be quite constant, but, on the other hand, I have never seen a fairly recent specimen in which the peristome did not show traces of colour, and have no reason to doubt that this character affords one of the surest methods of identification.

I have examined two good series of *ambiguosus*, from Mossel Bay and Vleesch Bay. The latter shells are more solid, and show more variation than the former. The dimensions of a few specimens, taken at random, are:—

Diam. maj.	33·0;	min.	26·30;	alt. max.	19·0
„	34·75;	„	27·0;	„	19·5
„	25·8;	„	22·2;	„	15·8

It is to be hoped that animals of this species may be procured and dissected, in order to find out whether the reproductive system shares those peculiarities which occur in *T. lucanus*.

TRIGONEPHRUS AMBIGUOSUS (Fér.) var. COMPACTUS, nov., 1915.

(Pl. II, f. 12.)

Shell subglobose, umbilicate, rather thin, semitransparent, chestnut-brown above, shading to greyish white beneath; peristome and callus yellow-brown. Spire moderately elevated, apex blunt. Whorls 5, moderately convex, rather gradually increasing, the apical smooth, remainder covered with close, faint, regular, transverse striae, with occasional faint malleation, especially on the upper surface of the last whorl, and a suggestion of microscopic granular sculpture, which is less apparent than in typical *ambiguosus*. Suture simple, rather shallow. Aperture rounded-ovate; peristome narrowly reflexed, ends joined by a thin callus. Columella weak and concave, margin scarcely overhanging the deep, narrow umbilicus.

Diam. maj. 24.1; min. 20.8; alt. max. 19.2; apert. 13.5 × 10.8 mm.; ends of peristome 7.7 mm. apart.

Animal unknown.

Hab. "SOUTH AFRICA."

Type in my collection.

I have seen three specimens, all nearly alike; the locality is doubtful, but it seems reasonable to suppose that they represent the form mentioned by Layard on p. 158 as inhabiting the George District.

If this is truly a variety of *ambiguosus*, it is indeed a remarkably aberrant one; but there is nothing in its coloration and sculpture, as well as in the general formation of its base and aperture, which is not consonant with its belonging to a close-coiled, high-spined race of the Mossel Bay form, and therefore, so long as the animal is unknown and the locality doubtful, I prefer to give it varietal rank, which it certainly deserves, rather than specific, to which it may not be entitled.

GENUS DORCASIA, Gray, 1838.

(Alexander's Expedition, ii. p. 268.)

Shell rather large, depressed or depressed-globose, perforate, usually rather thin and corneous with little or no ornamentation. Whorls 5-6, rather gradually increasing; sculpture consisting of fairly close, transverse, sometimes costate striae, which are more marked and regular than in *Trigonephrus*, where they pertain rather to the nature of growth-lines. Aperture rather small; peristome interrupted or continuous, seldom thickened, but more or less broadly reflexed. Umbilicus sometimes deep and perspective, but more frequently shallow and eccentric.

Animal differing from *Trigonephrus* in the following respects. Footsole rather indistinctly tripartite, having two shallow grooves, which diverge from a point about $1\frac{1}{2}$ mm. in front of the hind end, and can be traced forward nearly to the anterior end of the sole. Kidney narrower at the anterior end than in *Trigonephrus*; having a slight fold or ledge running along its right side, and overhanging the band of modified epithelium which takes the place of the ureter. Pedal gland tending to emerge into the body-cavity. Cerebral ganglia usually unpigmented. Jaw rather narrow, and less than 2 mm. long. Radula nearly three times as long as it is broad; teeth smaller than in *Trigonephrus*; central and lateral teeth unicuspid; marginals usually bicuspid, rarely tricuspid owing to

the doubling of the ectocone; bases of central teeth usually longer than their cusps. Reproductive system: free oviduct not much swollen; receptacular duct more than twice the length of the free oviduct, crossing the front end of the common duct; vas deferens keeping to the left of the free oviduct, usually loosely bound to the penis, not terminating in an epiphallus; penis longitudinally folded inside, and lined by diagonal rows of very minute papillae.

Distribution.—Usually in the vicinity of rivers in the sandy deserts of Great and Little Namaland, extending eastward into Bæchuanaland and northward through Damaraland.

Genotype *Dorcasia alexandri*, Gray.

Dorcasia is undoubtedly very closely allied to *Trigonephrus*. The two genera, however, can be distinguished externally, both by the sculpture and lip of the shell, and by the footsole of the animal; while internally they differ in their digestive, reproductive, and excretory systems, the difference in the radula being the most striking (see Pl. IV., figs. 9–16).

On the whole *Dorcasia* seems to be a rather more highly specialized genus than *Trigonephrus*, and it is probably not quite so old. It has therefore been thought advisable to describe *Trigonephrus* first and *Dorcasia* afterwards.

DORCASIA COAGULUM (von Martens).

(Pl. III, f. 1. Pl. IV, f. 5, 14, 22, 26, 30. Pl. V, f. 6.)

1889 *Helix coagulum*, von Mts., Sitz.-Ber. Ges. Nat. Fr. Berlin p. 160. *D.*

1897 „ von Mts., Archiv f. Naturg. lxiii. i. p. 37. Pl. VII, f. 11–14. *D.F.*

Shell rather large, subglobose, narrowly umbilicate, thin, translucent, pale corneous above and at sides, with irregular blotches and streaks of opaque cream; apex brown; base and peristome white; interior colourless, exhibiting the markings of the exterior. Spire somewhat produced, apex roundly obtuse. Whorls $5\frac{1}{2}$, rounded, rather gradually increasing, all but the $1\frac{1}{2}$ apical covered with close, faint, regular, transverse striae, becoming much fainter beneath. Suture simple, of moderate depth. Aperture truncate-ovate; peristome slightly reflexed, ends joined by an extremely faint callus. Umbilicus very deep and narrow, somewhat strangulate.

Dimensions of a specimen from Fielding's Chabeesies, nearly agreeing in shape with those of the Type set: Diam. maj. 22·8,

min. 18.5; alt. max. 17.2; apert. 13.2×11 mm.; ends of peristome 5.6 mm. apart.

Animal of specimens from Fielding's Chabeesies and Stinkfontein.—

Colour (in alcohol): whitish, tinged with grey towards the hind end of the foot and on the head; mantle-edge pale, but roof of mantle-cavity greyish near the edge, and along the rectum and one or two of the chief veins. Left body-lobe consisting of two portions connected by a fold, both divisions being prominent, though the left one is narrow (see Pl. IV., fig. 5, which also shows the arrangement of the pulmonary veins and the form of the kidney, in which features the present species does not differ much from the other members of the genus). Pedal gland partially embedded in the muscles of the foot.

Jaw 1.6 to 1.7 mm. long, rather narrow, thin, yellow-brown (Pl. IV., fig. 22). Radula of a Fielding's Chabeesies specimen, the shell of which measured 24 mm. in diameter, 4.6×1.8 mm.; transverse rows of teeth trending slightly forwards on each side of the middle line, where they form a very obtuse angle; cusps of inner marginals longer than in the other species (see Pl. IV., fig. 14, which shows the shapes and sizes of individual teeth); ectocones can be distinguished on about 70 per cent. of the teeth, though they are sometimes very small; formula $(45 + 1 + 45) \times 137$. A specimen from Stinkfontein had a very similar radula measuring 4.6×1.9 mm., the teeth being almost identical in appearance with those figured, and the formula being $(48 + 1 + 48) \times 135$. Crop and salivary glands surrounded with darkly pigmented connective tissue (Pl. IV., fig. 26).

Reproductive system (Pl. IV., fig. 30; Pl. V., fig. 6): hermaphrodite duct very slender and closely convoluted; vesicula seminalis rather small; free oviduct somewhat swollen; receptaculum seminis small, with a slender duct; vagina rather long; vas deferens rather closely bound to the penis for the greater part of its length; penis long, curved posteriorly.

Hab. GREAT NAMALAND. Between Aos and the Orange River. LITTLE NAMALAND. Stinkfontein; Fielding's Chabeesies.

The Type set is in the Berlin Museum.

It consists of two shells, one so bleached that its ornamentation is unrecognizable; the other smaller and apparently some time deceased, but showing clearly the beautiful mottling, which is such a prominent characteristic of the species. With the Types is another bleached example, agreeing with them in form, from the Lower Orange River.

The height of spire varies greatly. Von Martens gave the measurements of his larger shell as: Diam. maj. 24, min. 19; alt. 20 mm.; and his smaller one, as measured by myself, is: Diam. maj. 20, min. 15.4; alt. max. 14 mm. Most of the examples brought by Rogers from Little Namaland are comparatively lower in the spire, measuring $25.3 \times 20.5 \times 15.5$; $22.8 \times 19 \times 15.6$; $22.6 \times 18.5 \times 15.2$; $22.5 \times 18.2 \times 13.8$; and $21.5 \times 17.3 \times 13.6$ mm. In all of these the umbilicus is a little smaller and less overhung by the columellar margin than in the Type pair, but the discrepancy is not sufficient to necessitate varietal distinction. The callus is variable, being entirely absent in some fully formed shells and quite distinct in others.

This species might perhaps be regarded as one of the more primitive members of the genus, though the radula is of a somewhat specialized type. In the form of the shell and reproductive organs *D. coagulum* approaches *Trigonephrus* more nearly than do the other known species of *Dorcasia*; nevertheless the sculpture of the shell, the tripartite footsole, the form of the kidney, the internal structure of the penis, and especially the unicuspid central and lateral teeth of the radula, prove beyond doubt that this species belongs to the genus *Dorcasia*.

The shell is peculiar for South Africa, being far more reminiscent of the Mediterranean *H. vermiculata*, Müll., than of the neighbouring forms of its own genus.

DORCASIA ROGERSI, sp. nov., 1915.

(Pl. III, f. 2, 3. Pl. IV, f. 15, 23. Pl. V, f. 7. Text-fig. 1, C, D.)

Shell rather small, umbilicate, depressed orbicular, fairly solid, translucent, calcareous, creamy white, with slight, irregular, fawn blotches and spots, which are chiefly present on the third whorl; apex pale corneous; peristome white. Spire depressed, but each whorl, in profile, projects clearly above the next; apex rounded. Whorls 5, narrowly rounded, regularly increasing, the two apical smooth, remainder prettily sculptured with close, transverse striae, which become rather coarser and less regular towards the aperture and are hardly visible on the base. Suture deep, very little crenulate. Aperture almost circular; peristome reflexed, ends joined by a very slight callus. Columella very weak, margin slightly thickened and reflexed, but not approaching the umbilicus, which is perspective and very deep, but not wide.

Diam. maj. 21.1, min. 17.5; alt. max. 11.7; apert. 9.7×8.9 mm.; ends of peristome 4.3 mm. apart.

Animal of specimens from T'Kaigas:—

Colour (in alcohol) whitish, roof of mantle-cavity tinged with grey near the edge and along the rectum. Pallial organs very similar to those of *D. coagulum* (cf. Pl. IV., fig. 5). Pedal gland partially embedded in the muscles of the foot, especially at the hind end (Text-fig. 1, C, D).

Jaw 1.3 mm. long, rather narrow, thin, yellow-brown (Pl. IV., fig. 23). Radula of specimens, the shells of which measured about 21 mm. in diameter, 3.9×1.3 mm.; transverse rows of teeth trending slightly forwards on each side of the middle line, where they form a very obtuse angle; teeth broad and short (Pl. IV., fig. 15); ectocones are present on about two-thirds of the teeth; formula of one specimen $(35 + 1 + 37) \times 128$, of another $(30 + 1 + 30) \times 137$. Crop and salivary glands surrounded with darkly pigmented connective tissue.

Reproductive system (Pl. V., fig. 7): hermaphrodite duct long, very slender, and closely convoluted; vesicula seminalis rather small; free oviduct scarcely swollen; receptaculum seminis small, with a slender duct; vagina long; vas deferens rather closely bound to the anterior half of the penis, but only loosely attached further back; penis rather small and slender, curved at the hind end.

Hab. LITTLE NAMALAND. T'Kaigas (Rogers).

Type in South African Museum.

Eight examples, the smallest measuring: Diam. maj. 18.3, min. 14.8; alt. max. 8; apert. 8.5×7.4 mm.

I have founded this new species on a series of small shells in perfect condition, of which some of the animals have been available for dissection. It is possible, however, that the Type represents the smallest race of a species which usually attains much greater dimensions, for I have seen examples from Henkries District, Little Namaland, apparently conspecific with those from T'Kaigas, but attaining such dimensions as:—

Diam. maj. 27.9, min. 21.7; alt. max. 12.2; apert. 14.0×11.4 mm.
and „ 33.9, „ 26.8; „ 18.0; „ 18.5×14.2 „

The last of these is illustrated on Pl. III., fig. 3. They are too long dead to be classified with any certainty, but they agree in form with the smaller shells, and show calcined traces of a mottling, which would probably correspond, in life, to that which appears on the early whorls of the Type set.

Although connecting links may doubtless be found, all these shells, large and small, can at present be clearly distinguished from other

known species of *Dorcasia*. They have neither the continuous peristome of *alexandri* nor the open umbilicus and comparatively small aperture of *cernua*, while *coagulum* is a more globose form, with more rapidly increasing whorls.

In many features of its internal anatomy *D. rogersi* bears a close resemblance to *D. coagulum*. The radula, however, is very distinct; for not only are there fewer teeth in each transverse row, but the shape of the teeth is different, the inner marginals being quite unlike those of *D. coagulum*, as will be seen from the figures. The reproductive organs are very simple, the relatively small size of the penis being, perhaps, the most characteristic feature.

I should not be surprised to find that the new species is more nearly allied to *D. cernua*, when live examples of the last-named are available for examination; the difference in the umbilicus and aperture, however, should always afford means of distinction.

DORCASIA CERNUA (von Martens).

(Pl. III, f. 4.)

1889 *Helix cernua*, von Mts., Sitz.-Ber. Ges. Nat. Fr. Berlin, p. 161. *D.*

Shell large, flat, deeply umbilicate, rather thick and solid, but translucent, type bleached white, but exhibiting faint traces of mottling, which would probably represent patches of colour in a live specimen. Spire hardly raised. Whorls $5\frac{1}{2}$, rounded, gradually increasing, the last descending so abruptly and steeply in front that when the empty shell rests in its natural position the interior can hardly be seen; surface almost smooth, the fine, close, regular transverse striation, which is present on all but the first $1\frac{1}{2}$ whorls, being only just visible without a lens. Suture shallow. Aperture comparatively small, ovate; peristome thickened and reflexed, ends joined by a thick callus. Umbilicus wide and deep, extending to the apex.

Dimensions of Type: Diam. maj. 30.5, min. 24.5; alt. max. 12.5; apert. 14.3×10.7 mm.; ends of peristome 5.5 mm. apart.

Animal unknown.

Hab. GREAT NAMALAND. Angamthal; Kuibis; Rooiberg (subfossil).

Type in Berlin Museum.

With this is another subfossil shell from Rooiberg, near Bethany. It is much smaller than the Type, spire more raised, sculpture slightly more pronounced, whorls 5, the last not descending so far nor so

abruptly. Aperture almost circular, the ends joined by so thick a callus as to make the peristome practically continuous. Umbilicus wide and deep, as in the Type, and it is owing to this feature, in particular, that I agree with von Martens in considering the two shells conspecific.

The measurements of this smaller form are : Diam. maj. 19·3, min. 15·6 ; alt. 9·4 mm.

The abrupt final descent of the last whorl, which causes the entire peristome to lie flat on the ground and conceal the aperture when the shell is in its normal position, is not of such specific value as it was considered by von Martens. In large series, both of *D. alexandri* and its var. *rotundata*, I have seen some examples in which this feature is very marked, while, in the generality of specimens, the descent is either less abrupt or less extensive, so that the interior of the empty shell is plainly visible from the front, when the shell is laid in its normal position.

As will be seen from the figures, the Type, with its extraordinarily flattened spire and small aperture, looks almost like an abnormal example ; but Dr. Thiele informs me that there are two more subfossil shells, from Kuibis, in the Berlin Museum, both very similar to the Type, so that the form is probably well established and distributed, and should be easily distinguishable from others of the genus.

DORCASIA ALEXANDRI, Gray.

(Pl. III, f. 5.)

1838 *Dorcasia alexandri*, Gray, Alexander's Expedition, ii. p. 268. *D.*

Shell large, depressed-globose, rimate-perforate, rather thin, translucent, type bleached white, but normally corneous ; peristome white. Spire but little raised ; apex obtuse. Whorls 5, the later rapidly increasing, all but the $1\frac{1}{2}$ apical covered with very fine and close, regular, curved transverse striae, almost disappearing on the base ; last whorl swollen, so that it is nearly as high as the spire, ascending slightly at the suture and descending very abruptly, nearly perpendicularly, in front, almost concealing the aperture. Suture well defined, simple. Aperture rounded ovate ; peristome continuous, free, margins not thickened but widely and strongly reflexed, though not overhanging the perforation, which is narrow, strangulate, and so eccentric that a portion of the penultimate whorl is fully disclosed.

The measurements agreeing most nearly with those given in Gray's description, of a specimen in his Type set, are: Diam. maj. 32·6, min. 24·8; alt. max. 15·5; apert. 13·7 × 11·7 mm.

Animal only known from a single, slightly immature specimen, from "Herero and Namaland"! examined by Simroth and Pilsbry. According to their descriptions and figures, the possession of the following characters distinguishes the typical form of *D. alexandri* from the other members of the genus.

Pedal gland lying free in the body-cavity. Jaw* "entirely smooth," with little or no median projection. Radula† with teeth resembling those of the var. *rotundata*, but broader in front, and the centrals and laterals with longer basal plates. Reproductive system‡: free oviduct not swollen, vagina long, vas deferens not attached to the side of the penis, but free throughout; penis rather long, becoming thicker and bending abruptly towards the hind end, extending 1½ mm. beyond its junction with the vas deferens, to form a short terminal caecum or flagellum, on the apex of which the penial retractor is inserted.

Hab. GREAT NAMALAND. Neighbourhood of the Great Fish River. LITTLE NAMALAND. Neighbourhood of the Orange River.

Type set in British Museum.

Judging from the descriptions of Simroth and Pilsbry the typical form of *D. alexandri* differs widely from the other known members of the genus in possessing a smooth jaw and a terminal caecum on the penis; for in all the remaining forms that have been examined the jaw is transversely striated, and the penis scarcely extends at all beyond its union with the vas deferens, as will be seen from the figures. It must be remembered, however, that the observations of both these authors were made on the same specimen, which was stated to be badly preserved and slightly immature; and it is therefore to be hoped that further material will be collected in order that a new examination of the anatomy may be made.

Many varieties have been attributed to this species. The typical form is chiefly known from the neighbourhood of the Lower Orange River; I have seen one beautiful example of dark reddish-corneous hue, and it is possible that when further good species have been collected this coloration will be found to prevail in the comparatively smooth typical form, and to supply additional ground for its specific separation from varieties such as *rotundata*.

* Man. of Conch., 1895, ix. Pl. LX, f. 3.

† Ibid. Pl. LX, f. 6.

‡ Ibid., frontispiece, f. 3, and Ber. Senckenb. Naturf. Ges. Frankfurt, 1894, p. 94, text-figs.

DORCASIA ALEXANDRI, Gray, var. MINOR, O. Boettger.

(Pl. III, f. 6.)

1886 *Helix (Dorcasia) alexandri*, Gray, var. *minor*, Bttg., Ber. Senckenb. Naturf. Ges. Frankfurt, p. 22. Pl. II, f. 1.

Shell differing from typical *D. alexandri* in being smaller, and in having a comparatively higher spire, very slightly more pronounced sculpture above, and a deeper, less eccentric umbilicus.

Animal unknown.

Hab. BECHUANALAND. Ghous.

GREAT NAMALAND. Geitsi Gubib.

Type in Senckenberg Museum, Frankfurt am Main.

The example figured, S.A.M. No. A 2818, from Geitsi Gubib, measures: Diam. maj. 22·6, min. 18·8; alt. max. 13·5; apert. 11·0 × 9·9 mm.

Böttger founded the variety on five specimens from Ghous, north of Smalvisch Kop, Gordonina, and gives the measurements as: Diam. 21–24; alt. 10–11½; apert. 10–10½ × 11–12 mm.

Almost every intermediate size between the typical form and the smaller variety can be found, the sculpture, height of spire, and consequent form of the umbilicus being by no means constant.

DORCASIA ALEXANDRI, Gray, var. ROTUNDATA, Mousson.

(Pl. III, f. 7. Pl. IV, f. 6, 16, 24. Pl. V, f. 8, 11.)

1887 *Helix alexandri*, Gray, var. *rotundata*, Mouss., J. de C. xxxv. p. 292. Pl. XII, f. 1. *D.F.*

1914 *Dorcasia alexandri*, Gray, var. *siegmanni*, Honigmann, Nachrichtsbl. d. D. Mal. Ges. lxiv. p. 29. *D.F.*

Shell depressed-globose, umbilicate, thin, semitransparent, pale corneous, peristome white and glossy. Spire depressed, each whorl, in profile, just projecting above the next; apex obtuse. Whorls 4¼, narrowly rounded, rapidly increasing, all but the apical sculptured with close, regular, transverse costae, which become closer and finer, but show very clearly, on the base and extend into the umbilicus; last whorl descending very abruptly in front. Suture deep, simple. Aperture rounded-ovate; peristome quite free, continuous, widely reflexed, but in no way overhanging the umbilicus, which is deep, but strangulate and very narrow.

Dimensions of a specimen from Rehoboth: Diam. maj. 21·1, min. 16·8; alt. max. 12·3; apert. 10·8 × 9·2 mm.

Animal of full-grown specimens from the same locality.—

Colour drab, possibly due to immersion in strong spirit; roof of mantle-cavity apparently unpigmented. Left body-lobe divided into two separate portions, the left being rather small and not connected with the right by any fold or ridge (see Pl. IV., fig. 6, which also shows the arrangement of the pulmonary veins and the form of the kidney). Pedal gland embedded in the muscles of the foot at its hind end, but emerging into the body-cavity further forward.

Jaw 1.9 mm. long, rather thin, golden-brown; broader towards the middle, more pointed at the ends, and rather more curved than in *D. coagulum* and *D. rogersi* (Pl. IV., fig. 24). Radula of a specimen, the shell of which measured about $21\frac{1}{2}$ mm. in diameter, 5×1.8 mm.; transverse rows of teeth almost straight; teeth less diverse in shape than in *D. coagulum* and *D. rogersi*; outer marginals with squarer bases (Pl. IV., fig. 16); ectocones are present on about five-eighths of the teeth; formula $(39 + 1 + 40) \times 139$. In another specimen several of the rows of teeth are abnormally shortened and crowded, the formula being $(41 + 1 + 41) \times 166$, and the radula measures 5.2×1.8 mm. Crop and salivary glands apparently unpigmented. Buccal retractor united with the left tentacular retractor for a longer distance than in the other species.

Reproductive system (Pl. V., fig. 8): hermaphrodite duct very slender and closely convoluted; vesicula seminalis long; common duct abruptly curved at its anterior end; free oviduct scarcely swollen, receptaculum seminis larger than in *D. coagulum* and *D. rogersi*; vagina long; vas deferens very loosely attached to the side of the penis; the part next to the posterior half of the penis is closely convoluted, the convolutions being bound together by a sheath of connective tissue; penis long, curved and contorted, especially towards the posterior end, though the bends occupy different positions in different individuals.

Hab. DAMARALAND. Rehoboth District.

Type of *rotundata* in Zurich Museum; *siegmanni* in coll. Natermann.

The published figures of *rotundata* hardly convey a proper idea of the actual shell, as they entirely fail to show the well-marked basal sculpture, which is its most prominent characteristic. This unfortunate omission was the cause of its being re-described by Honigmann under the varietal name of *siegmanni*. However, at the instance of Herr Carl Natermann, cotypes of the last-named form have been compared by Dr. O. Stoll, of Zurich, with the type set of *rotundata*, and pronounced inseparable. Both were

described from the Rehoboth District, and are known, as yet, from no other locality.

In a large series, the shape of the peristome and the relative position of the umbilicus differ considerably. The peristome may be either acuminate-ovate or nearly circular; the last whorl, also, may descend very abruptly in front and cause the peristome to be entirely solute, or less abruptly, when the peristome may be almost adnate. The striation is not quite constant, being perceptibly closer in some specimens, both above and beneath, than in others.

The dimensions vary considerably, a few specimens, taken at random, measuring:—

Diam. maj.	25.2,	min.	20.0;	alt. max.	13.5;	apert.	12.2 × 11 mm.
„	25.1,	„	20.0;	„	13.2;	„	12.3 × 9.8 „
„	22.0,	„	17.0;	„	13.0;	„	10.7 × 9.5 „
„	21.8,	„	17.1;	„	13.0;	„	11.2 × 9.5 „

This form differs anatomically from the other members of the genus that have been examined in several minor features, one of the most striking being the close convolution of the posterior part of the vas deferens. Although the vas deferens is not wholly detached from the side of the penis, as is said to be the case in the typical form of *D. alexandri*, it is much more loosely joined to it than in *D. coagulum* and *D. rogersi*; and it is interesting to note that this gradual separation of the vas deferens from the wall of the penis is correlated with the lengthening and contortion of the latter organ, just as in *Trigonephrus lucanus*. The jaw is striated, and the caecal prolongation of the penis, described as occurring in the typical form of *D. alexandri*, is absent from this variety.

DORCASIA ALEXANDRI, Gray, var. TRIVIA, O. Boettger.

1910 *D. alexanderi*, Gray, var. *trivia*, Bttg., Abh. Senckenb. Naturf. Ges. Frankfurt, xxxii. p. 439. Pl. XXVIII, f. 3. *D.F.*

I have not seen this variety, the following notes on the Type being compiled from information kindly rendered by Dr. Haas.

Shell intermediate in size between the typical form and var. *minor*, but of thinner texture. The elevation of the whorls and general form of the aperture and umbilicus are similar to typical *alexandri*, but the sculpture consists of raised, rather distant costae, from $\frac{1}{2}$ to 1 mm. apart, whereas the fine striae of *alexandri* are far closer together, 3 to the mm. on the last whorl.

Animal unknown.

Hab. DAMARALAND. Khoma's Plateau.

Type in Senckenberg Museum.

Boettger founded this variety on 13 specimens, and gives the measurements as : Diam. 24-30; alt. 14-15 mm.

DORCASIA ALEXANDRI, Gray, var. PERSPECTIVA, nov., 1915.

(Pl. III, f. 8.)

Shell depressed-globose, umbilicate, thin, semitransparent, type pale buff, peristome white and glossy. Spire flattened, each whorl, in profile, just projecting above the next; apex obtuse. Whorls $4\frac{1}{2}$, very rounded, fairly rapidly and regularly increasing, the apical smooth, remainder beautifully sculptured with curved transverse costae, at first close, fine and regular, gradually becoming coarser and, towards the aperture, irregularly waved or broken and wider apart. The last whorl descends abruptly in front, but not so as to conceal the aperture entirely. Aperture roundly ovate; peristome continuous, broadly reflexed, quite free and clearly projecting from the last whorl, but in no part overhanging the umbilicus, which is broad and very deep, so that the apex is fully disclosed and quite transparent.

Diam. maj. 29.0, min. 22.0; alt. max. 12.8; apert. 13.8×11.5 mm.

Animal unknown.

Hab. DAMARALAND. Omaruru River (A. Wohlfahrt).

Type in Kimberley Museum.

This is the most northerly form of *alexandri* yet known. The Type set, being almost subfossil, are nearly colourless, but would doubtless be pale corneous were they in live condition.

The shell differs from that of var. *trivia*, Boettger, in having even coarser sculpture, and in its umbilicus being very broad and deep instead of more or less shallow and narrow, as in other described forms of *alexandri*. The dimensions vary considerably. I have selected the largest example as Type; others measure respectively :—

Diam. maj. 26.0, min. 19.8; alt. max. 11.0 mm.

„ 23.0, „ 18.5; „ 10.5 „

„ 22.6, „ 18.2; „ 10.7 „

„ 22.0, „ 17.4; „ 10.1 „

A glance at *D. alexandri* and its varieties will show that, if they all belong to the same widely distributed species, it is an extremely

variable one. Little reliance can be placed on the comparative size of the shell, height of the spire, or shape of the aperture, but the perforation varies from a slit to a well, and the sculpture from fine and regular to irregular and costate. Moreover, the difference in anatomy between the only two forms which have yet been examined may well be more than merely varietal. It is quite possible, therefore, that, when we have a better knowledge of their anatomy and exact distribution, more than one of the so-called varieties of *alexandri* will be proved worthy of specific rank. On the other hand, it will be seen that the gradual, constant divergence from Type increases quite regularly in a northerly direction, from the rimate typical form with hardly visible sculpture in the south, through *rotundata* and *trivia*, to the widely umbilicate *perspectiva* with costate sculpture in the north. This gradual divergence is less incompatible with all the forms belonging to one species than if they were scattered about indiscriminately, irrespective of geographical restrictions. I therefore prefer, for the present, not to disturb the varietal arrangement; it can easily be done later, if warranted by the occasion.

GENUS TULBAGHINIA, Melv. & Pons., 1898.

A.M.N.H. i. p. 28.

Shell rather large, depressed-globose, umbilicate, usually corneous and ornamented with bands or mottling; peristome thickened or reflexed, sometimes showing weak dentition on the columella.

Animal unknown.

Distribution.—The South-western district of the Cape Province, chiefly in the more wooded areas between Tulbagh and Bredasdorp.

Genotype, *Tulbaghinia isomerioides* (M. & P.).

Founded as a sub-genus of *Dorcasia* for *T. isomerioides*, on account of its peculiar columellar formation. As it is extremely doubtful whether this species belongs to the *Dorcasinae* at all, it is obviously advisable to raise *Tulbaghinia* to generic rank. I have no hesitation in including *schaerfiae*, Pfr., in the genus on account of its close conchological affinity with the genotype.

The general appearance of the shell, especially the white, thickened peristome, recalls certain members of the *Dorcasinae*, and, until more is known of the animal, I am content to regard the genus as representing the sylvan races of the subfamily.

TULBAGHINIA ISOMERIOIDES (Melv. & Pons.).

1898 *Dorcasia* (*Tulbaghinia*) *isomerioides*, M. & P., A.M.N.H. i. p. 28. Pl. VIII, f. 10. *D.F.*

Shell rather large, depressed-globose, umbilicate, fairly thin, translucent, bright corneous, slightly paler beneath; peristome white and glossy; interior showing the colour of the exterior. Spire depressed, apex very obtuse. Whorls $5\frac{1}{2}$, rounded, rather gradually increasing, all but the apical covered with close, curved, well-defined transverse striae, the earlier whorls showing considerable faint malleation, and the last, clear microscopic granulation. Suture simple, rather shallow. Aperture truncate-ovate; peristome narrowly reflexed, ends joined by a thin callus. Columella furnished with three small protuberances on the inner edge; outer columellar margin forming a distinct angle of 130° 3.8 mm. from its junction with the paries.

Dimensions of Type: Diam. maj. 30.0, min. 24.6; alt. max. 15.8; apert. 16.2×12.4 mm.; ends of peristome 4.1 mm. apart.

Animal unknown.

Hab. CAPE PROVINCE. Tulbagh.

Type in British Museum.

Only three specimens are known, and in these the peculiar columellar dentition is variable, there being three processes in the Type and only two in another example. The last mentioned, which I described in Vol. XI. p. 152 of these ANNALS, also differs widely from the Type in coloration, being dark olive-brown, beautifully mottled with yellow on the upper whorls. Whether this, or the uniform brown of the Type, is the normal colour scheme of the species, will be proved when further examples come to hand.

Although the little protuberances on the columella may prove to be of specific value in the case of *T. isomerioides*, something of a similar nature is of irregular, though infrequent occurrence in other *Dorcasiinae*. Possibly owing to its slime attracting minute particles of sand, the parietal region of *Trigonephrus globulus* is sometimes quite rough with brown, horny points, while even in the shell figured (Pl. II, f. 1) a somewhat similar excrescence is noticeable on the exterior of the outer lip. I have also seen an example of *T. gypsinus*, which showed a minute, perfectly formed denticle just inside the basal margin of the aperture.

TULBAGHINIA SCHAEERFIAE (Pfeiffer).

1861 *Helix schaeerfae*, Pfr., Mal. Blätt., viii. p. 73. Pl. II, f. 1-3. *D.F.*

Shell depressed orbicular, umbilicate, thin, glossy, semitransparent, bright corneous, with several narrow, regular, spiral rufous

bands, more frequent above, but also present, though fewer and fainter, beneath; peristome white and glossy; interior nacreous blue. Spire flattened. Whorls 4, flattish, rapidly increasing and expanding, covered with close, regular, transverse striae which impart a satin-like appearance to the shell. Suture simple, rather shallow. Aperture quadrate-oval; peristome very slightly thickened. Columella extremely weak. Umbilicus deep and open.

Dimensions of a shell from Oudebosch, in my collection: Diam. maj. 29.9, min. 24.0; alt. max. 14.7; apert. 14.6×13.0 mm.; ends of peristome 8.2 mm. apart.

Animal unknown.

Hab. CAPE PROVINCE. Bredas Bosch and Oudebosch.

Type in Stettin Museum, from Bredas Bosch.

Layard's notes on this species run: "Of this beautiful shell there are three very distinct varieties:—

(a) a pale, almost white var., marked with sparse, faint, brown lines;

(b) also pale, but covered with close-set, well-marked, dark brown longitudinal lines.

"These two varieties are from the open veldt at Bredasdorp, and are, except slightly on the underside, destitute of epidermis. This, I conceive, is burnt off by the sun, for at Oudebosch, in Caledon District, in the forest, my son and I took (c) a lovely variety, of a dark brown colour, covered with a beautiful transparent epidermis, quite polished and glistening on the underside, through which the dark brown bands of the shell show quite plainly. In this locality the shells are protected from the sun by the dense forest. I never saw this shell from any other localities than those named, and it is there not a common species."

The pale coloration of Layard's vars. (a) and (b) is not due to loss of epidermis, as I have seen similarly marked specimens in excellent condition. The ground colour is pale cream, and the narrow reddish bands may be either quite conspicuous or almost invisible.

APPENDIX.

UNDETERMINED VARIETIES.

A few specimens which have come under examination are not referable to any of the preceding forms, but, owing either to insuffi-

cient material or poor condition, I have not ventured to found new species on them. When live examples come to hand, some of them will doubtless prove worthy of names.

I append rough diagnoses of the more remarkable.

1. TRIGONEPHRUS, spec. (S.A.M. No. A 2817).

Shell somewhat resembling in contour a small, blunt-apexed *T. porphyrostoma*, bleached and subfossil, but once, apparently, of brownish colour with reddish purple peristome. Whorls 5, sculpture resembling that of *rosaceus*. Aperture similar to that of *globulus*; peristome much thickened, columellar margin *completely overgrowing the umbilicus*, so that the shell appears to be imperforate.

Alt. max. 37·8; diam. 33·5; apert. 19·6 × 17·5 mm.; ends of peristome 12·75 mm. apart.

Animal unknown.

Hab. GREAT NAMALAND. Granite Berg, 27° 30' S.; 15° 30' E. (Rogers).

Possibly an aberrant form of *porphyrostoma*.

2. TRIGONEPHRUS, spec. (S.A.M. No. 8235a).

Shell slightly elongate-globose, thin, semitransparent, dark reddish brown; peristome brown. Spire a little produced, apex bluntly rounded. Whorls $4\frac{1}{2}$, rapidly increasing, all but the apical covered with close, faint transverse, and microscopic spiral striae. Aperture quadrate-ovate, shaped like that of *T. globulus*; peristome moderately thickened and reflexed, half concealing the narrow umbilicus.

Alt. max. 25·8; diam. 21·1; apert. 13·5 × 10·1 mm.; ends of peristome 9·6 mm. apart.

Animal unknown.

Hab. CAPE OF GOOD HOPE. St. Helena Bay (Gould).

A single specimen, possibly a sport from the local race of *globulus*, but differing in its darker colour and the absence of the infra-sutural white band, while in form resembling a squat *T. namaquensis*, var. *procerus*, rather than *globulus*. A longer series is necessary before its exact status can be determined.

3. TRIGONEPHRUS, spec.

A little brown shell, almost similar in shape to *T. ambiguus*, var. *compactus*, but considerably smaller, with a white peristome. Its

dimensions are: Diam. maj. 21, min. 17·3; alt. max. 15·8; apert. $11·3 \times 9·3$ mm.

Two specimens, labelled "Namaqualand," in the Layard Collection. I am uncertain whether they can be the pair mentioned as from Namaqualand on p. 146, or whether they are not rather the small form of *lucanus* from Bredasdorp (p. 158). Under such circumstances, it seems inadvisable to name them.

4. *DORCASIA ALEXANDRI*, var. (S.A.M. No. A 2819).

Shell similar to the typical form in all respects except the sculpture, which, though much worn, appears to be slightly more pronounced, and the umbilicus, which is very wide and open, deep and perspective, extending to the transparent apex.

Diam. maj. 28·1, min. 22·8; alt. max. 14·2; apert. 15×11 mm.

Animal unknown.

Hab. DAMARALAND. Erongo Mountains (Rogers).

A connecting link between the var. *perspectiva*, which it resembles in its open umbilicus, and the typical form, which it nearly resembles in sculpture. The locality, however, being just north of the Onaruru, suggests that it is a smoothish sub-variety of *perspectiva*, rather than a widely umbilicate one of the true *alexandri*.

5. *HELIX BULBUS*, Menke.

1848 *Helix bulbus*, Mke., Pfr., Zeitschr. f. Malak. v. p. 116. *D.*

1853 " " " " Conch Cab., p. 268. Pl. CXXII (1852),
f. 4-6. *D.F.*

Apparently founded on a single specimen, whose present whereabouts cannot be traced.

A translation of Pfeiffer's diagnosis runs: "Shell moderately umbilicate, globose-depressed, thin, irregularly rugose and sculptured with impressed concentric lines; white; spire flattish. Whorls $4\frac{1}{2}$, almost flat, the last rounded, scarcely descending in front. Aperture oblique, lunate-oval, interior white, shining; peristome simple, margins approximating, the right lip straight, curved forward; the basal very slightly reflexed; the columellar margin dilated. Shell $26 \times 21\frac{1}{2}$; alt. 13 mm."

"**Hab.** CAPE, in coll. Menke."

The description and figure should be quite sufficient for the identification of the species, should it ever be rediscovered. Not only, however, do the conspicuous spiral striae suggest little affinity

with the *Dorcasinae*, but the shell appears to be quite unlike anything known to exist in South Africa, though, were it not for the spiral sculpture, it might be attributable to some bleached form of *Natalina*.

Failing the reappearance of the Type, therefore, I am inclined to believe that the locality quoted is erroneous, and, for this reason, to expunge *H. bulbosus* altogether from the South African list and place it in the category of lost species.

PLATE II.

- Fig. 1.—*Trigonephrus globulus* (Müll.); from a specimen in my collection.
,, 2.—*T. globulus*, forma *minor*; from a specimen in my collection.
,, 3.—*T. gypsinus* (Melv. & Pons.); from the Type in British Museum.
,, 4.—*T. rosaceus* (Müll.); from a specimen in the South African Museum.
,, 5.—*T. rosaceus*, forma *minor*; from a specimen in my collection.
,, 6.—*T. porphyrostoma* (Melv. & Pons.); from a specimen in the South African Museum.
,, 7.—*T. namaquensis* (Melv. & Pons.); from a specimen in the South African Museum.
,, 8.—*T. namaquensis*, var. *procerus*, nov.; from the Type in coll. Ponsonby.
,, 9.—*T. namaquensis*, var. *procerus* ?; from a specimen in the South African Museum.
,, 10.—*T. lucanus* (Müll.); from a specimen in my collection.
,, 11.—*T. ambiguosus* (Fér); from a specimen in my collection.
,, 12.—*T. ambiguosus*, var. *compactus*, nov.; from the Type in my collection.

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West, Newman del. et lith.

PLATE III.

- Fig. 1.—*Dorcasia coagulum* (v. Mts.); from a specimen in the South African Museum.
- „ 2.—*D. rogersi*, nov.; from the Type in the South African Museum.
- „ 3.—*D. rogersi*, forma *maxima*; from a specimen in the South African Museum.
- „ 4.—*D. cernua* (v. Mts.); from the Type in Berlin Museum.
- „ 5.—*D. alexandri* (Gray); from the Type in British Museum.
- „ 6.—*D. alexandri*, var. *minor*, Bttg.; from a specimen in the South African Museum.
- „ 7.—*D. alexandri*, var. *rotundata*, Mouss.; from a specimen in the South African Museum.
- „ 8.—*D. alexandri*, var. *perspectiva*, nov.: from the Type in Kimberley Museum.

West, Newman del. et lith

SPECIES OF DORCASIA.

PLATE IV.

ANATOMY OF THE DORCASIINAE.

Figs. 1-6.—*Pallial organs* seen from below, showing the arrangement of the pulmonary veins, with the mantle-edge and left body-lobes above, the pericardium and kidney below, and the rectum on the left side. (Somewhat diagrammatic.)

- Fig. 1.—*Trigonephrus globulus* (Müll.).
- „ 2.—*T. porphyrostoma* (M. & P.).
- „ 3.—*T. namaquensis* (M. & P.).
- „ 4.—*T. lucanus* (Müll.).
- „ 5.—*Dorcasia coagululum* (v. Mts.).
- „ 6.—*D. alexandri*, var. *rotundata*, Mouss.

Figs. 7 & 8.—Dorsal views of *buccal mass*, showing the end of the radula-sac and the opening of the oesophagus. (Natural size.)

- Fig. 7.—*Trigonephrus globulus* (Müll.).
- „ 8.—*T. namaquensis* (M. & P.).

Figs. 9-16.—Representative teeth from the *radula* (seen from above).

- Fig. 9.—*Trigonephrus globulus* (Müll.) $\times 150$.
- „ 10.—*T. rosaceus* (Müll.) $\times 150$.
- „ 11.—*T. porphyrostoma* (M. & P.) $\times 150$.
- „ 12.—*T. namaquensis* (M. & P.) $\times 150$.
- „ 13.—*T. lucanus* (Müll.) $\times 175$.
- „ 14.—*Dorcasia coagululum* (v. Mts.) $\times 250$.
- „ 15.—*D. rogersi*, nov. $\times 250$.
- „ 16.—*D. alexandri*, var. *rotundata*, Mouss. $\times 250$.

Figs. 17-24.—Anterior views of *jaw*.

- Fig. 17.—*Trigonephrus globulus* (Müll.) $\times 7.5$.
- „ 18.—*T. rosaceus* (Müll.) $\times 7.5$.
- „ 19.—*T. porphyrostoma* (M. & P.) $\times 7.5$.
- „ 20.—*T. namaquensis* (M. & P.) $\times 7.5$.
- „ 21.—*T. lucanus* (Müll.) white var. $\times 7.5$.
- „ 22.—*Dorcasia coagululum* (v. Mts.) $\times 10$.
- „ 23.—*D. rogersi*, nov. $\times 10$.
- „ 24.—*D. alexandri*, var. *rotundata*, Mouss. $\times 10$.

Figs. 25 & 26.—*Digestive system*, seen from above, after the intestine and rectum, with the anterior division of the liver, have been turned over to the left.

- Fig. 25.—*Trigonephrus porphyrostoma* (M. & P.) $\times 1$.
- „ 26.—*Dorcasia coagululum* (v. Mts.) $\times 2$.

Figs. 27-30.—Part of the wall of the *penis*, seen from within.

- Fig. 27.—*Trigonephrus globulus* (Müll.) $\times 6$.
- „ 28.—*T. porphyrostoma* (M. & P.) $\times 5$.
- „ 29.—*T. lucanus* (Müll.) $\times 6$.
- „ 30.—*Dorcasia coagululum* (v. Mts.) $\times 6$.

PLATE V.

ANATOMY OF THE DORCASIINAE.

Figs. 1-8.—*Reproductive organs*, showing the genital opening above, the albumen gland and vesicula seminalis below, the hermaphrodite gland on the right, the penis on the left, and the receptaculum seminis in the middle.

- Fig. 1.—*Trigonephrus globulus* (Müll.) $\times 3$.
,, 2.—*T. rosaceus* (Müll.) $\times 1.5$.
,, 3.—*T. porphyrostoma* (M. & P.) $\times 1.5$.
,, 4.—*T. namaquensis* (M. & P.) $\times 3$.
,, 5.—*T. lucanus* (Müll.) $\times 2.25$.
,, 6.—*Dorcasia coagulata* (v. Mts.) $\times 3.3$.
,, 7.—*D. rogersi*, nov. $\times 3.3$.
,, 8.—*D. alexandri*, var. *rotundata* (Mouss.) $\times 4$.

Figs. 9-11.—*Spermatozoa*, showing the head and anterior end of the tail.

- Fig. 9.—*Trigonephrus globulus* (Müll.) $\times 1,200$.
,, 10.—*T. lucanus* (Müll.) $\times 1,200$.
,, 11.—*Dorcasia alexandri*, var. *rotundata*, Mouss. $\times 1,200$.

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