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XXXII.—*Notes on Slugs, chiefly in the Collection at the British Museum.* By T. D. A. COCKERELL.

THE following notes result from a study of various species of slugs, many of them new or hitherto ill-understood, which I have been able to examine recently. Most of the specimens referred to are in the British Museum, though some few are in private collections. I have to thank Mr. E. A. Smith for affording me every facility at the Museum; and I am also greatly indebted to Mr. W. G. Binney for the opportunity of examining many species of American slugs.

I. *ARIOLIMAX*, *ANADENUS*, AND *PROPHYSAON*.

This group of *Arion*-like slugs has not been very well understood, partly, no doubt, because of the difficulty of obtaining specimens of the species. I have been fortunate in seeing quite a large series of forms, which I tabulate as follows:—

A. Sole not differentiated into parts; respiratory orifice anterior; genital orifice close to right eye-peduncle.

(1) No caudal mucus-pore. . . . Gen. *Prophysaon*, Bld. & Binn., 1873.

Sect. *a. Fasciati*. Body with dark dorsal band.

i. Jaw ribbed *P. fasciatum*, Ckll.

ii. Jaw striate, not ribbed. *P. humile*, Ckll. (præc. var.?).

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Sect. *b. Cærulei*. Body without dorsal band, reticulation comparatively simple iii. *P. cæruleum*, Ckll.

Sect. *c. Typici*. Body with a pale dorsal line.

iv., v. Ochreous species. *P. pacificum*, Ckll., and *P. flavum*, Ckll. (præc. var.?).

vi., vii. Greyish species. *P. Andersoni*, Coop., and *P. Hemphilli*, B. & B. (præc. var.).

(2) With a caudal mucus-pore. Gen. (præc. subg.) *Phenacarion*, Ckll., 1890.

i. Back with no dark band.

P. foliolatum, Gould.

ii. Back with a dark band.

P. Hemphilli, W. G. Binn.

B. Sole differentiated into parts; respiratory orifice nearly median or slightly posterior.

(1) No caudal mucus-pore.

(1a) Genital orifice close to right eye-peduncle; back keeled.

Gen. nov. *Anadenulus*, Ckll.

i. *A. Cockerelli*, Hemph.

(1b) Genital orifice not close to right eye-peduncle; back not keeled.

Gen. *Anadenus*, Heyn., 1863.

Sect. *a. Sulcati*. Body with deep transverse sulci.

i. *A. Jerdoni*, G.-Aust.

Sect. *b. Altivagi*. Body with oblique fine sulci.

ii. *A. altivagus*, Theob.

iii. *A. modestus*, Theob. (præc. juv.?).

iv. *A. Schlagintweiti*, Heyn.

(Sect. ? v., vi. *A. Blanfordi*, G.-A., *A. insignis*, G.-A., not seen by me.)

(2) With a caudal mucus-pore; genital orifice not close to right eye-peduncle Gen. *Ariolimax*, Mörch, 1860.

Sect. *a. Maximi*. Large species.

i. *A. columbianus*, Gould. (California to British Columbia.)

ii. *A. californicus*, Cooper. (California.)

iii. *A. costaricensis*, Ckll., nov. (Costa Rica.)

Sect. *b. Parvuli*. Smaller species.

iv. Sole mottled *A. niger*, Coop.

v. Sole not mottled. . . *A. Hemphilli*, W. G. B.

(Also of this genus: vi. *A. Andersoni*, W. G. B.; vii. *A. Hecoxi*, Weth., spp. dub.)

Later on I shall have to publish some rather copious notes on the American species; meanwhile it will be useful to note:—

- 1) *Prophysaon humile*.—I do not feel certain that the character of the jaw is really specific; it may be an aberration, but this cannot be settled until we have a series of specimens to examine. I have placed the type specimen in the British Museum.
- (2) *Prophysaon flavum*.—The difference between the sole of this and *pacificum* observed may be partly due to postmortem contraction. Possibly *flavum* is a variety of *pacificum*.
- (3) *Prophysaon Andersoni*, Coop., has priority over *P. Hemphilli*, B. & B., and I cannot detect any specific difference between them. *P. Andersoni*, W. G. B., belongs to *Fasciati*, and is *P. fasciatum*, Ckll.
- (4) *Phenacarion* is very near to *Prophysaon*; indeed it is most difficult to separate *P. foliolatum* and *Pr. Hemphilli* specifically. I have not seen any good material of *Phen. Hemphilli*, W. G. B., but it appears to be a distinct species. If *Phenacarion* is not kept as a genus and *Proph. Hemphilli* is regarded as distinct from *Andersoni*, then *P. (Phen.) Hemphilli* will require a new name.
- (5) *Anadenulus Cockerelli*.—I at first referred this species, of which I saw the types, to *Anadenus*; but it is really distinct enough to be separated from it, besides being American, while the true *Anadeni* are Asiatic. The genital orifice in true *Anadenus* is quite a long way from the right eye-peduncle, as in *Ariolimax*.
- (6) *Ariolimax columbianus* and *californicus* are hardly to be separated as species; *californicus* is more keeled and has a narrower sole. *A. Hecozi*, a third species from the United States, has never been described, and cannot be recognized. Mr. Binney informs me it is a large species.
- (7) *Ar. Andersoni*, W. G. B., is a doubtful species, probably a variety of *A. niger*. The "foliated appearance" is not specific, as it occurs also in *A. niger*.

Ariolimax costaricensis, subsp. nov.

A. californicus, subsp.—Length 68 millim. (in alcohol), mantle 27 millim. long, respiratory orifice 19 millim. from
20*

anterior border ; sole 17 millim. broad. Colour dark olivaceous. Back well keeled for about 18 millim., keel inclined to be flexuose. General form of *californicus*. Sole transversely wrinkled-sulcate, especially lateral areas. Rugæ like *californicus*, about 17 rows on each side of body, counting from dorsum to sole. Mantle rather finely granulose. Caudal pit distinct. Jaw dark, ribbed.

The alcohol in which they have been is coloured yellow.

Hab. Costa Rica (*Mr. Janson*). Four specimens in British Museum.

Anadenus Jerdoni, G.-Aust.

Godwin-Austen's type of this extraordinary slug, from Cashmere (coll. Jerdon), is in the British Museum ; I made the following notes supplementary to the original description :—Jaw dark, not greatly curved, with about twelve strong ribs. Body with transverse deep sulci, stronger than the longitudinal ones. Mantle broadly ovate. Colour entirely greyish ochreous. Respiratory orifice 28 millim. from anterior border of mantle. Mantle 38 millim. long. Slug about 90 millim. long. External genital orifice beneath anterior right border of mantle, 9 millim. from base of right eyepeduncle and 5 millim. from edge of sole. Sole with median and lateral areas not strongly differentiated. This species departs considerably from the ordinary type of *Anadenus*.

Anadenus altivagus, Theob.

Two specimens from Simla (*Theobald*) in British Museum, from which I made the following notes :—

Length 47 millim. Mantle oval, 22 millim. long, unicolorous, granulose ; respiratory orifice 14 millim. from anterior border. Sole very broad, lat. 18 millim. ; median area, lat. $6\frac{1}{2}$ millim., thus nearly the same width as either lateral area. Sole finely transversely wrinkled. Reticulations on body numerous and small, more longitudinal than transverse—*i. e.* oblique lines run from dorsum downwards and backwards, and these are connected by numerous longitudinal lines and reticulations between them. The oblique lines are about eight or ten on each side. Colour dull ochre, spotless ; neck grey above.

Another specimen in British Museum, from Sikkim (coll. Schlagintweit), is evidently also *altivagus*, but is 74 millim.

long; sole lat. $23\frac{2}{3}$ millim.; median area, lat. $10\frac{1}{2}$ millim., thus broader than either lateral area; lateral areas granulose.

Anadenus modestus, Theob.

With the Sikkim *altivagus* in the British Museum is the small specimen referred to by Godwin-Austen (Land and Freshwater Moll. India, 1882, p. 54). It has the oblique lines on the back characteristic of section *Altivagi*, and also the flattened tail. It is $19\frac{1}{2}$ millim. long; mantle 8 millim. long, respiratory orifice slightly posterior, *i. e.* 5 millim. from anterior border. Sole, lat. $5\frac{1}{2}$ millim., median zone broader than either lateral. Colour dull greyish ochreous, with lateral black marbling on mantle (representing broken-up lateral bands) and black lateral bands, irregular in outline, on body. This is very possibly the young of *A. altivagus*, but it is also apparently Theobald's *modestus*. Heynemann described a similar form as the young of *Schlagintweiti*. If the young of *altivagus* is striped, no doubt the young of a species so closely allied as *Schlagintweiti* would be similar, and the immature slugs might be very hard to distinguish specifically. There can be no doubt, supposing these striped slugs are juveniles, that Theobald's *modestus* is the young of *altivagus* or *Schlagintweiti*.

Anadenus Schlagintweiti, Heyn.

Colour grey, slightly olivaceous, becoming white beneath mantle posteriorly. Neck and head dark above. Sole narrower than in *altivagus*, median area approximately of equal width to either lateral area. Mantle 24 millim. long, respiratory orifice slightly anterior to middle. Back with flatter rugæ than in *altivagus*, but pattern of reticulation the same. These notes are from a specimen in the British Museum marked "Coll. Schlagintweit, Simla to Sulsanpor [Sultanpur, in G.-A. Moll. Ind.], Himalaya," and, apparently in Dr. Heynemann's writing, "*Anadenus Schlagintweiti*."

Another specimen in the British Museum from Kulu, Himalaya (*Schlagintweit*), is also *Schlagintweiti*, but has the sole more wrinkled and the median area narrower; colour also darker, but the white below mantle conspicuous.

A. Schlagintweiti is exceedingly closely allied to *altivagus*, but it may be a good species. It is easily distinguished by its different coloration.

II. THE TANDONIA SECTION OF *AMALIA*.

The keeled slugs, referred by modern authors to the genus *Amalia*, Moquin-Tandon, were divided by Lessona and Pollonera in 1882 into groups—PIRAINEA, the group of *A. gagates*, and TANDONIA, the group of *A. carinata* and *A. marginata*. A third group, having an incomplete keel, is *Malinastrium*, Bourg. (= *Subamalia*, Poll., 1887). The TANDONIA section is credited by Pollonera with twelve species, but several of them are very closely allied—not more distinct, indeed, than other races almost universally considered varieties. Probably the number of species will be greatly reduced when it becomes possible to compare living examples and dissect fresh specimens of all of them.

I give here a list of the recorded forms, with notes :—

Amalia marginata (Drap.).

Known by its small spots and banded mantle. There is a specimen in the British Museum from Waldeck, received from Dr. Heynemann, from which I made the following notes :—

25 millim. long (in alcohol), narrower than *carinata*, and hardly arched. Sole ochrey; median area hardly twice as broad as one lateral area. Keel straight, ochreous. Body ochreous at sides, bluish grey dorsally, with a peppering of dark grey points all over (except under mantle and on sole). Mantle with lateral dark bands fading away anteriorly.

This is quite a distinct species and quite different from the English slug, *carinata*, Leach, usually called *marginata*. I have never seen an English example of true *marginata*, nor can I find any evidence of its occurrence in the British Islands by searching the literature. The figure and description by Rimmer (Land and Freshwater Shells of British Islands, 1880) belong to the true *marginata*, but they are copied apparently from the French, and have actually no reference to an English slug. Heynemann (Die nacktl. Landp. des Erdbodens, 1885) gives *A. marginata* as British, but he was probably misled by British authors. Roebuck ('Science Gossip,' 1884, p. 78) records var. *rustica* from Gloucestershire; but it is probable—I think practically certain—that he had not the true *rustica*, Mill., as understood in France*, but a variety of *A. carinata*.

* Kreglinger, 1870, gives *rusticus*, Mill., as a synonym of *L. (Lehmania) marginatus*, Müll.

A. pyrrichus, Mab., is a form of *marginata*, and var. *rufula*, Moq.-Tand. (Moll. de France, pl. ii. fig. 4), also belongs here.

A. rusticus, Mill., 1843, appears to be another form of the same species as given by Moquin. *L. carinatus* of Daniel, Heidelberg list (Quart Journ. Conch. vol. i. p. 113), may be true *marginata*, and not Leach's species. Var. *mongianensis*, Paul., from Calabria (near Mongiana), is probably referable also to *marginata*.

Amalia marginata, form *pyrrichus* (Mabille).

Amalia marginata, form *rufula* (Moq.).

Amalia marginata, form *rustica* (Mill.).

Amalia marginata, var. ? *mongianensis*, Paulucci, 1879.

Amalia Reuleauxi, Clessin, 1887.

Amalia Reuleauxi, form *punctata*, Cless.

I have not seen a sufficient description of *Reuleauxi*, but it seems allied to *marginata*.

Amalia carinata (Leach).

1820. *Limax carinatus*, Leach, Moll. of G. B. pl. viii. fig. 3.

1823. *Limax Sowerbyi*, Fér. pl. viii. D.

1840. *Limax carinatus*, J. E. Gray, Man. of Land and Freshwater Shells Brit. Is., by W. Turton, new ed. pp. 115, 116, fig.

1844. *Limax carinatus*, Brown, in text (*Sowerbii* on plate), Ill. Rec. Conch. Gt. Brit. and Irel. pl. lviii. fig. 6, pl. lix. fig. 14.

1863. *Limax Sowerbyi*, L. Reeve, Land and Freshwater Moll. Brit. Is. p. 17, fig. 1.

1866. *Limax Sowerbii*, R. Tate, Land and Freshwater Moll. Gt. Brit. fig. 13.

1875. *Limax Sowerbii*, S. P. Woodward, Man. of the Mollusca, 3rd ed. fig. 124.

1882. *Milax Sowerbyi*, Locard, Cat. Gen. des Moll. viv. France.

1883. *Amalia marginata*, Roebuck, Journ. of Conch. April, p. 40.

The above (excepting the second and the last two) are references to British figures of this species, all representing Leach's species, and not Draparnaud's *marginata*. The slug has been elsewhere described by several authors, but the bibliography here given will suffice for present requirements. The older authors correctly referred it to *carinata*, but the reference to *marginata*, "Müller" or "Drap.," has been universal in England of late years, and needs correcting. *Limax marginatus*, Müller, is not even an *Amalia*.

Leach's type, marked "*Limax carinatus*, given by R. Latham," is still in the British Museum*; it is a rather large pale specimen.

A. carinata is easily known from *marginata* by its dark sulcus on the mantle and the usually dark-reticulated body. There is in the British Museum a specimen of *A. carinata* from Ecuador, collected by Mr. Buckley; doubtless it is an introduced species in that country. It is rather remarkable that the species has not yet been introduced into North America.

Amalia carinata, form *Sowerbyi* (Fér.).

Férussac's *Sowerbyi* is simply a form of *carinata*, bright-coloured and with strong markings.

Amalia carinata, form *bicolor* (Ckll.).

Amalia marginata, var. *bicolor*, Ckll. Sci. Goss. Aug. 1887, p. 187.

Sides black, keel and sole orange.
Ealing, Middlesex.

Amalia carinata, form *fuscocarinata* (Ckll.).

Amalia marginata, var. *fuscocarinata*, Ckll. Nat. World, Sept. 1886, p. 179.

Keel coloured like the rest of the body.
Bedford Park, Middlesex.

Amalia carinata, form *rustica* (Roeb.).

Amalia marginata, var. *rustica*, Roeb. Sci. Goss. 1884, p. 78; Journ. of Conch. Oct. 1885, p. 363.

Colour grey, without any admixture of brown or yellow.
This is apparently not *rustica*, Mill.

* The British Museum also possesses specimens of *Amalia carinata* from the following localities in England:—Comm. Docks, London, S.E. (*J. E. Daniel*); S. Shields (*R. Howse*); near London (*J. E. Harting*); Bedford Park, Chiswick (*T. D. A. Cockerell*); and a few others without locality precisely given. One big specimen of *A. carinata* is marked "*L. carinatus* and var. *pallida* (*J. E. Daniel*)."
I cannot ascertain that any var. *pallida* of the species has been described. The specimen from Ecuador, presently to be mentioned, was collected by Mr. Buckley, purchased of E. Gerrard. It is 36 millim. long, mantle 12½ millim. long, sole pale ochrey, median area twice as broad as either lateral area. It differs in nothing from those found near London. Among the Bedford Park lot is a specimen of form *nigrescens*.

Amalia carinata, form *nigrescens* (Roeb.).

Amalia marginata, var. *nigrescens*, Roebuck, MS., Ckll., Nat. World, Sept. 1886, p. 179.

Dark grey or nearly black, without an internal shell.

Middlesex and Surrey.

This is an extreme dark form, and, curiously enough, though several specimens have been carefully dissected by two or three conchologists, no shell has been found present. *Limax Ehrenbergi*, Bourg., a form of *L. flavus*, is similarly said to have no shell.

Amalia fulva (Paulucci).

Amalia carinata, Leach, subspecies.

Limax carinatus, Risso, 1826.

Milax carinatus, Locard, Cat. Gen. Moll. France, 1882.

The southern form of *carinata*, known as *carinata*, Risso, has been considered a distinct species from that of Leach by Locard and others ; but it appears to be only a subspecies at best. Risso's name is later than Leach's, so it cannot be used according to the law of priority. *A. argillaceus*, Gass., 1856, has been quoted under *carinata*, Risso, but it is really a synonym of *carinata*, Leach.

A. marginata, var. *fulva*, Paulucci, 1879, belongs to the southern slug, being the young or a slight variety, and I have adopted this as the earliest available name for the subspecies.

Amalia fulva, form *typus* (Less. & Poll.).

Amalia fulva, form *pallidissima* (Less. & Poll.).

Amalia fulva, form *insolita* (Less. & Poll.).

Amalia fulva, var. *oretea* (Less. & Poll.).

Amalia fulva, var. *casertana* (Less. & Poll.).

For these varieties see Lessona and Pollonera's excellent monograph of the Italian slugs.

Amalia Eichwaldii (Kal.).

Amalia carinata, Leach, subspecies.

Krynickyllus Eichwaldii, Kaleniczenko, Bull. Soc. Imp. Nat. Mosc. 1851, tab. vi. fig. 1 a, b.

The figure represents a small pale brown slug with a con-

spicuous yellow keel. No sulcus visible on mantle. Body dark-reticulate.

Amalia Pacomei (Florence).

Milax Pacomei, Florence, Bull. Soc. Mal. France, 1889, p. 326.

A doubtful species; perhaps a form of *A. fulva*.

Amalia Hessei, Bttg.

Amalia carinata, Leach, subspecies.

A small slug from Corfu, having the markings on the mantle ω -like. This ω -like marking is not a specific character, as it is more or less visible on *carinata*, *marginata*, *oretea*, *baripus*, and *pallidula*.

Amalia pallidula, subsp. nov.

Amalia carinata, Leach, subspecies.

Length (in alcohol) 17 millim.; mantle, length $6\frac{1}{4}$ millim.; sole broadish, diam. 3 millim. Colour entirely pale ochrey, or back and mantle more brownish, mantle-sulcus slightly brown. Head pale ochrey, tentacles greyish. Mantle broad, squarish-blunt before and behind. Body narrowish, very strongly and highly keeled. Reticulations by strong grooves, forming flattened elongate-squarish rugæ, interstitially smooth and shiny. Sole with the median area not twice as broad as either lateral area, pale ochrey, unicolorous. Respiratory orifice well posterior. Grooved striæ in median area of sole as numerous as in lateral areas. Keel not flexuose. Tail flattened laterally, not at all attenuate. A delicate subtransparent species.

Described from two specimens in the British Museum, presented by Dr. J. E. Gray.

Habitat unknown, but probably South European.

Allied to *A. gracilis*, *A. Kobelti*, and *A. Hessei*, and perhaps only to be regarded as a variety of one of them.

Amalia Kobelti, Hesse.

Amalia carinata, Leach, subspecies.

A unicolorous yellow species from Greece.

Amalia gracilis, Leydig, 1876.

Smaller than *carinata*, and mantle without black sulcus-marking. *A. cibiniensis*, Kim., is a synonym.

Amalia gracilis, form *budapestensis* (Hazay, 1881).

Hazay's figure represents an elongate slug, nearly unicolorous palish sepia, tail quite tapering, head and tentacles blackish or grey.

Amalia baripus (Bourg.).

Milax baripus, Bourg. Moll. Nouv. Lit. ou peu connus, 1863-1868, pl. xxxii. figs. 7-10.

Hab. Syria.

Bourguignat's figure represents a small pale bluish *Amalia*, keel pale, head and tentacles pale violaceous; mantle with the sulcus and a posterior median short line or band black.

Amalia cristata (Kal.).

Krynockillus cristatus, Kal. Bull. Soc. Imp. Nat. Mosc. 1851, tab. v. figs. 1 a, b.

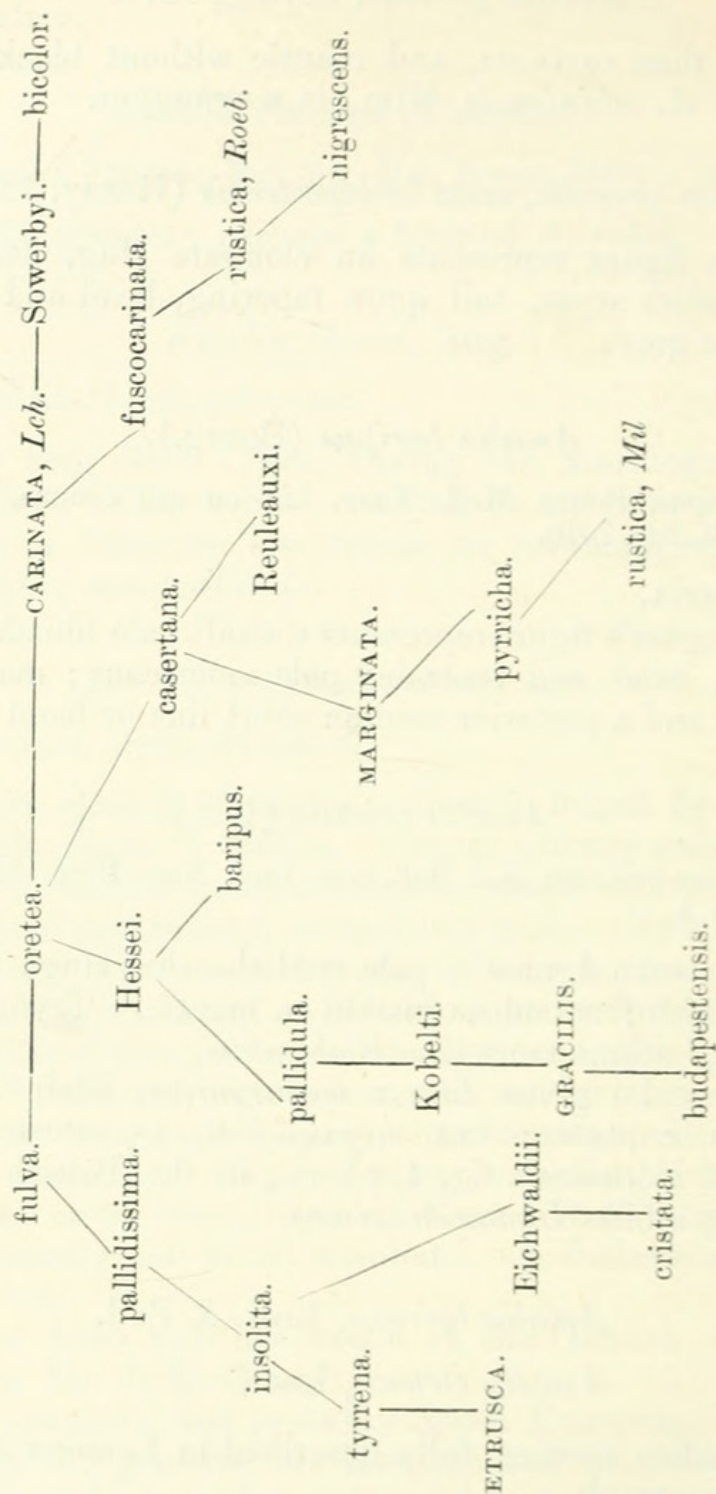
Kaleniczenko figures a pale reddish-ochre slug; head and neck blackish; no sulcus visible on mantle. Tryon's "*cristata*, Kal.," seems more like *Eichwaldii*.

Kaleniczenko gives *Limax megaspidius*, Blainv., as identical with *cristatus*; but *megaspidius*, as attested by the original of Férussac's fig. 4, pl. vi., in the British Museum, is a young albino *Limax maximus*.

Amalia tyrrena, Less. & Poll.*Amalia etrusca*, Issel.

Two Italian species, fully described in Lessona and Pollo-nera's monograph.

To sum up, I give here a table showing the relationships of the various forms as nearly as I can make them out.



3 Fairfax Road, Bedford Park, Chiswick, W.,
August 24, 1890.



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