June 15, 1875.

Prof. Newton, F.R.S., V.P., in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of May 1875.

The total number of registered additions to the Society's Menagerie during the month of May was 165. Of these, 100 were acquired by presentation, 34 by purchase, 4 by exchange, 18 by birth, 1 by hatch, and 8 were received on deposit. The total number of departures during the same period, by death and removals, was 113.

The most noticeable additions during the month of May were as follows:—

1. A Hairy Tree-Porcupine (*Cercolabes villosus*, F. Cuv.) from South-East Brazil, and

2. A Rock-Cavy, ♂ (*Cerodon rupestris*, Max.), from the same country. Both of these Rodents, which were purchased on May 5th of a dealer in Liverpool, are new to the Society's collection.

3. A fine example of the King Penguin (*Aptenodytes pennanti*) from the Falkland Islands, presented by Mr. Frederick E. Cobb, Manager of the Falkland-Islands Company at Stanley, Falkland Islands, received May 18th.

4. An example of an apparently new species of Monkey allied to the common Macaque (*Macacus cynomolgus*), presented by Dr. Marfels, Conservator of Forests to the King of Burmah, Mandalay, Burmah, and brought home by Dr. J. Anderson, F.Z.S., May 19th. Dr. Anderson will give us a complete description of this Monkey.

5. A small Wallaby of a species new to the Society's Menagerie, purchased May 28th. It appears to be, as kindly suggested by Mr. Gould, an example of the Agile Wallaby (*Halmaturus agilis*), Gould's 'Mammals of Australia,' ii. pls. 24 & 25, from North Australia.

6. An about half-grown Australian Cassowary (*Casuarius australis*), from Queensland, presented by E. P. Ramsay, Esq., C.M.Z.S., May 28th, making the second example of this hitherto little-known species now alive in the Gardens.

7. Two Jameson's Gulls (*Larus jamesoni*), from Sydney, N.S.W., presented by C. Moore, Esq., C.M.Z.S., May 28th, being the first example of this beautiful species we have received alive.

A letter was read, addressed to the Secretary by Dr. A. B. Meyer, stating that he had made inquiries of Mr. Van Musschenbroek, of Ternate, as to the truth of the statement of Mr. Bruyn (P. Z. S. 1875, p. 30) that he had specimens of four species of Birds of Paradise living in his possession, and had ascertained that this was not the fact, and that the only living Birds of Paradise in Mr. Bruyn's possession were two examples of *Paradisea papuana*. The only foundation for the story was that Mr. Bruyn *expected* to get specimens of other species.

Sir Victor Brooke exhibited original drawings by Mr. Wolf of the two species of Koodoo, *Tragelaphus strepsiceros* and *T. imberbis**, and pointed out the distinctions between these two animals. The figure of the latter was taken from a specimen received by Sir Victor Brooke from the Juba river, Somali Coast, which was, no doubt, the true habitat of this species.

Mr. Sclater read a memoir on the Rhinoceroses now or lately living in the Society's Menagerie. This will be published in the Society's 'Transactions.'

Prof. Owen, C.B., F.R.S., read the twenty-first of his series of memoirs on the extinct birds of the genus *Dinornis* of New Zealand, and their allies. The present paper contained an account of some bones of *Harpagornis moorei*, found in the turbaries of Glenmark, near Christchurch, New Zealand.

Dr. James Hector, F.R.S., exhibited a specimen of the pelvis of *Harpagornis moorei* of Haast, which had been found on the surface of the ground under a rock, in the province of Otago, New Zealand, by Mr. A. Low. It had been figured in Trans. N.Z. Inst. vol. vi., and was the property of the Colonial Museum, Wellington, N. Z.

Mr. G. Dawson Rowley, F.Z.S., exhibited skins of *Nasiterna geelvinkiana*, ♂ and ♀, which, as far as he knew, were new to this country; also an example of *N. pygmæa* ♂, to show the difference between the two species. It appeared that *N. geelvinkiana* was a trifle smaller than *N. pygmæa*.

The following papers were read :—

1. Descriptions of new or little-known Species of Bats of the Genus *Vesperugo*. By G. E. Dobson, M.A., M.B., F.L.S., &c.

[Received May 28, 1875.]

Genus Vesperugo.

Vesperugo, Keys. & Blas. Wiegm. Archiv, 1839, p. 312.

a. Ears broad, rhomboidal; tragus expanded above and curved inwards; phalanges of third and fourth fingers short; a band of hair on under surface of the wing-membrane posterior to the forearm; wings not extending to the base of the toes; calcaneum distinct; premolars $\frac{2.2}{2.2}$. Subgenus *Vesperugo*.

1. Vesperugo stenopterus, n. sp.

Crown of the head very slightly elevated, almost level with the face-line; muzzle broad and flat, labial glandular prominences largely

* *Strepsiceros imberbis*, Blyth, P. Z. S. 1869, p. 51.

developed, the upper lip symmetrically thickened. Ears short; the distance between the base of the inner margin of the ear-conch and the termination of the outer margin near the angle of the mouth is equal to the distance from the base of the inner margin to the summit of the ear; integument forming the conch very thick, especially the lower half of the outer side; tragus short, broad above, narrow opposite the base of the inner margin.

Feet wholly free from the wing-membrane, which is attached to the tibia a short distance above the ankle; this and the shortness of the phalanges of the third and fourth fingers cause remarkable narrowness of the wings. Postcalcaneal lobe small, termination of calcaneum indistinct; tip of tail free. Fur dark brown throughout; integuments and wing-membrane dark brown or black.

The muzzle in front of the eyes, both above and beneath, is almost naked; and the distribution of the fur upon other parts is similar to that in *V. noctula*.

The upper incisors are similar to those of *V. noctula*; but the second upper premolar is separated by a small space from the canine, through which the small first premolar may be seen from without.

Length (of an adult male preserved in alcohol), head and body 2″·35; tail 1″·7; head 0″·75; ear 0″·6; tragus 0″·25 × 0″·15; forearm 1″·55; thumb 0″·32; second finger 2″·6; fourth finger 1″·65; tibia 0″·55; foot and claws 0″·45.

Hab. Sarawak, Borneo.

Type in the collection of the British Museum.

b. Ears longer than broad, triangular; tragus reaching its greatest width below the middle of the inner margin, longer than broad; no postcalcaneal lobule; wings from the base of the toes; premolars $\frac{2.2}{2.2}$. Subgenus *Alobus*, Ptrs.

2. Vesperugo pulcher, n. sp.

Crown of the head slightly elevated above the face-line; muzzle shaped more like that of some species of *Vespertilio* (*V. emarginatus*, e.g.), and the glandular prominences between the nostrils and eyes less developed than in most species of *Vesperugo*. Ears about four fifths the length of the head, the ascending inner margin straight or faintly convex, the upper half of the outer margin slightly concave, terminating in a line directly below the eye, but on a lower level than the angle of the mouth; tragus nearly half the length of the ear, shaped like that of *V. serotinus*.

Posterior margin of the interfemoral membrane festooned with distinct papillæ arranged like the teeth of a comb.

Fur above sienna-brown, with shining tips, beneath *wholly pure white*; the dark-coloured fur of the back does not pass beyond a line connecting the angle of the mouth (when the head is extended) and the under surface of the humerus. Interfemoral, antebrachial, and wing-membranes between the humerus and femur white; the remaining parts of the wing-membrane pale brown.

Inner upper incisor long, with a second cusp on its outer side near the extremity. Outer incisor short, lying close to the base of the inner incisor. Second premolar in the upper jaw separated from the canine by a short interval, through which the small first premolar is distinctly visible from without. Lower incisors not crowded.

Length (of an adult male preserved in alcohol), head and body 2″·0; tail 1″·6; head 0″·7; ear 0″·6; tragus 0″·25; forearm 1″·35; thumb 0″·28; second finger 2″·6; fourth finger 1″·9; tibia 0″·52; foot and claws 0″·3.

Hab. Zanzibar.

Type in the collection of the British Museum.

This species resembles *V.* (*Alobus*) *temminckii*, Rüpp., but may be at once distinguished by the form of the tragus, which is narrowed towards the tip and subacutely pointed, by the deeply fimbriated margin of the interfemoral membrane, by its much greater size, &c.

c. Ears triangular, the outer margin terminating in a distinct well-defined round lobe midway between the base of the tragus and the angle of the mouth; lobule at base of outer margin of tragus very small or absent; postcalcaneal lobe distinct; wings from the base of the toes; *base of the thumbs and soles of the feet with fleshy pads as in Tylonycteris*; premolars $\frac{2.2}{2.2}$. Subgenus *Glischropus.*

3. Vesperugo nanus.

Vesperugo nanus, Peters, Reise nach Mossambique, i. p. 63.

Resembles *V. pipistrellus* in the general form of the muzzle and ears; but the ears are narrower, and their outer margin distinctly angularly emarginate opposite the base of the tragus, terminating in a sharply defined, projecting round lobule; the inner margin is regularly slightly convex from the base to the tip, which is shortly rounded off; the upper half of the outer margin distinctly concave. Tragus without triangular lobule or projection at the base, narrowest opposite the base, broadest opposite the upper fifth of the inner margin, the outer margin sloping inwards above to join the inner margin, and form with it a narrow rounded terminal projection curved slightly inwards.

Base of the thumb swollen, rounded, the surface marked with deep wrinkles; the sole of the foot similarly swollen and wrinkled, but flat, or slightly concave as in *Tylonycteris pachypus*; toes short, about half the length of the whole foot. Postcalcaneal lobe distinct, rounded, placed on the calcaneum at a distance equal to about three fourths the length of the foot from the end of the tibia. Tail as long as the head and body, the extreme tip projecting. Above dark brown or black, with shining tips; beneath brown or black at the base, with ashy extremities.

Upper incisors nearly equal in length, inner incisors bifid at extremities, outer unicuspidate. Lower incisors distinctly trifid, and not crowded. Second upper premolar separated from the canine by a narrow interval, through which the small first is visible from without.

Length, head and body 1″·6 ; tail 1″·6 ; head 0″·55 ; ear 0″·45 ; tragus 0″·22 ; forearm 1″·2 ; thumb 0″·22 ; second finger 2″·25 ; fourth finger 1″·65 ; tibia 0″·5 ; foot and claws 0″·22.

Hab. Africa ; eastern and western coasts.

4. Vesperugo tylopus, n. sp.

Muzzle broad and evenly rounded in front ; nostrils opening on a level with the glandular prominences on each side, and without intervening emargination ; glands of the upper lip greatly developed, forming smooth, almost naked prominences, causing a furrow along the centre of the face behind the nostrils. Ears triangular, narrowed above, with rounded tips, the ascending part of the inner margin very faintly convex, nearly straight ; the upper third of the outer margin straight, succeeded by a considerable convexity, causing the upper third to appear concave, then distinctly angularly emarginate opposite the base of the tragus, and terminating in a well-defined lobe midway between the base of the tragus and the angle of the mouth, but on a lower level than the mouth. This angular emargination and round terminal lobe are even better-defined than in *V. nanus.* Tragus faintly concave along inner margin, outer margin slightly convex, tip obtusely rounded off ; a minute very acutely pointed projection slightly above the base of the outer margin.

Thumb rather long ; *the whole of the lower surface of basal half occupied by a naked rounded callosity* of a pale yellow colour (in alcohol), with transverse wrinkles ; the sole of the foot is similarly formed, but the surface is flat, or slightly concave. The light yellow colour of these callosities or elastic and adhesive pads of the thumbs and feet contrasts remarkably with the very dark colour of the integument of the surrounding parts.

Postcalcaneal lobe distinct ; extreme tip of tail projecting. Inner upper incisors long, bifid, the smaller cusp placed posteriorly and externally near the extremity ; outer incisors very short, but in transverse diameter equal to the inner ones, placed in a plane slightly anterior, the single cusp sloping inwards and lying against the cingulum of the inner incisors. Lower incisors trifid, not crowded. First upper premolar internal, but visible from without.

Length, head and body 1″·55 ; tail 1″·5 ; head 0″·55 ; ear 0″·5 ; tragus 0″·2 ; forearm 1″·2 ; thumb 0″·26 ; second finger 2″·4 ; fourth finger 1″·65 ; tibia 0″·55 ; foot and claws 0″·26.

Hab. North Borneo.

Type in the collection of the British Museum.

The peculiar structure of the sole of the foot and of the inferior surface of the thumb has not been previously noticed in *V. nanus,* and has hitherto been described in the genus *Tylonycteris* only. Among other Mammalian orders an homologous condition of the sole of the foot is found in *Hyrax* (in the arboreal species especially) by which these animals are enabled to run up the smooth faces of rocks and climb to the summits of lofty trees. As these animals have no prehensile claws, it would be impossible for them to mount trees without this special provision for climbing.

In *Tylonycteris* and *Glischropus* the fleshy foot-pads without doubt perform similar functions, probably enabling these Bats to cling to the under surfaces of large leaves and fruits, perhaps not so effectively, however, as the much more highly specialized pedunculated sucking-disks of *Thyroptera tricolor* enable that animal to adhere to smooth surfaces as securely as a fly.

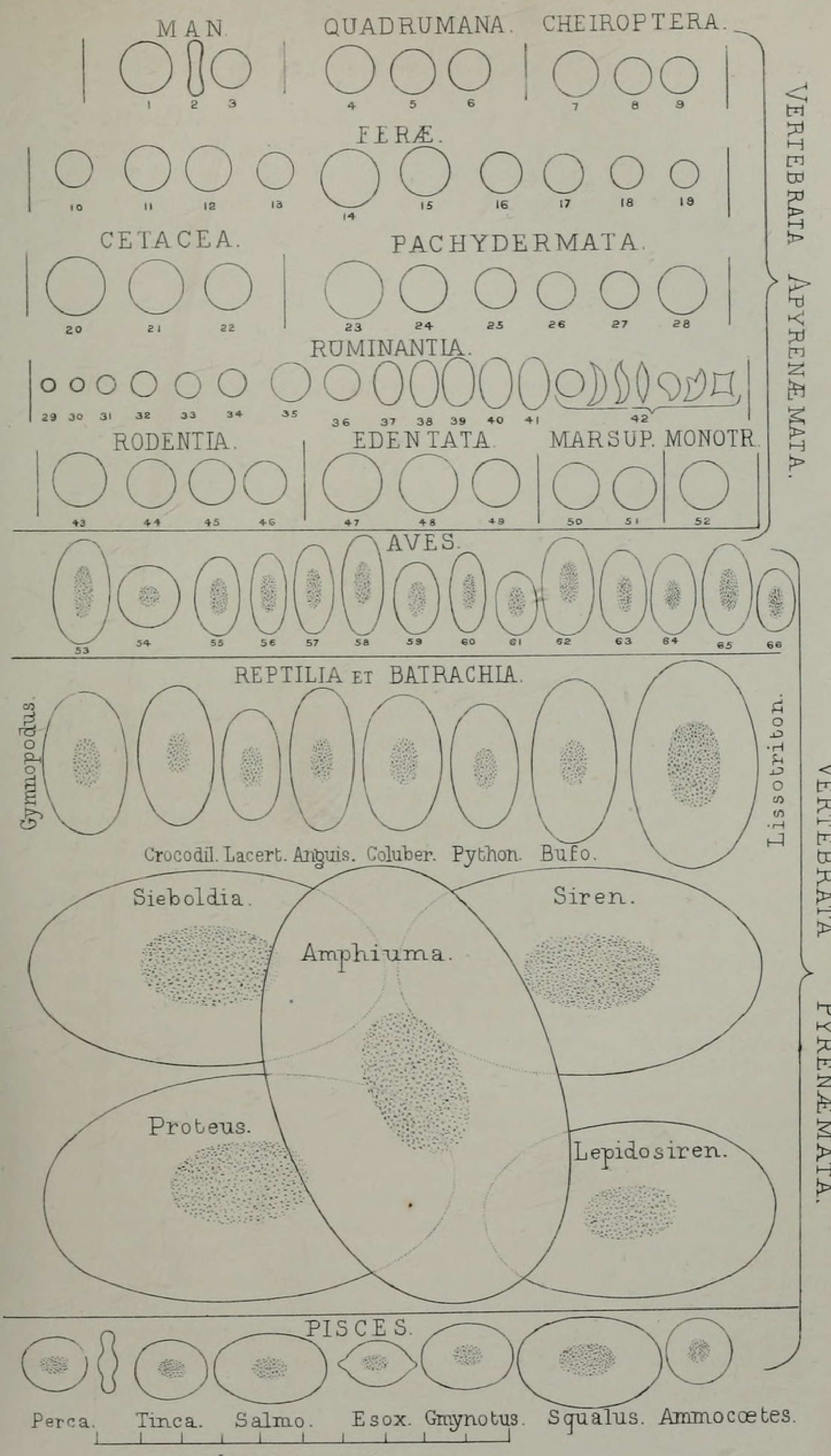
2. Observations on the Sizes and Shapes of the Red Corpuscles of the Blood of Vertebrates, with Drawings of them to a uniform Scale, and extended and revised Tables of Measurements. By GEORGE GULLIVER, F.R.S., late Professor of Comparative Anatomy and Physiology to the Royal College of Surgeons.

[Received May 31, 1875.]

(Plate LV.)

No physiologist is likely at the present day to undervalue, as John Hunter did, the importance of the red blood-corpuscles. They often afford valuable characters which, though regularly ignored in the books of systematic zoology, should always form a part of the descriptions of the orders, and sometimes of the species, of each class of vertebrate animals. Higher still is the physiological significance of the corpuscles; their relations of individual size and of aggregate proportions to the other constituents of the blood, and to the economy of the species (in which we now know that the corpuscles perform an important function intimately connected with their size and number), have become questions of much interest and moment which still require further investigation.

But such inquiry would be foreign to the present purpose, which is to give simply the averages, with brief explanatory comments, of numberless measurements, all made by me, in the hope that they may be useful towards further researches of the same kind. And so many are the facts either suggested or shown by my Tables, in relation to the significance of the comparative sizes of the corpuscles, that I can here make no attempt to consider or develop this branch of the subject. It has been admirably treated by Professor Milne-Edwards in his 'Leçons sur la Physiologie et l'Anatomie Comparée,' and was summarily noticed in my 'Lectures on the Blood, Lymph, and Chyle,' delivered at the Royal College of Surgeons, and reported (with engravings) in the 'Medical Times and Gazette,' 1862–3. On the taxonomic import of the nucleus of the red corpuscle, my observations (illustrated by woodcuts drawn to a scale) are published in the 'Proceedings' of this Society (P. Z. S. 1862, p. 91, et 1870, p. 92);



G. Gulliver del. M&N Hanhart lith.

RED BLOOD-CORPUSCLES.

the significance is intimated of the comparative minuteness of the corpuscles in the small species of single natural orders or families of Apyrenæmata and throughout the class of Birds.

Since the publication, upwards of a quarter of a century ago, of my Tables of Measurements, I have made so many additions and revisions by new observations, several of which have never been published, that nothing short of the present paper will suffice to give such a fair view of the whole series of averages as will be most useful for future reference, in relation to questions, often arising and likely to increase, concerning the import, whether taxonomic or physiological, of the sizes of the red corpuscles of the blood. The original Tables, which appeared in the 'Proceedings' of this Society (P. Z. S. 1845, p. 93) and in the Sydenham Society's edition of Hewson's Works, 8vo, 1846, followed my extensive observations on the same subject in the 'Lond. and Edin. Phil. Mag.' January 1840 to August 1842, and in the Appendix to the English version of Gerber's Anatomy, 8vo, Lond. 1842. Those measurements have been added to piecemeal up to the present year; and the tables from Hewson's Works were converted into French millimetres and transferred by Milne-Edwards to the first volume (8vo, Paris, 1857, pp. 84–90) of his great work already cited. Of course, as linear measurements only are used, all my remarks as to the sizes of the corpuscles are to be understood accordingly.

The measurements now recorded show the results of the labours of many years, and are far more copious than any others known to me, and, with the observations connected therewith originally, proved sundry facts, such as, *e.g.*:—the singular minuteness in the Tragulidæ of the red blood-corpuscles, their largeness in the Edentata and pinniped Feræ, and batrachian character in *Lepidosiren*; the comparative sizes of the corpuscles in several of the subsections of the vertebrate subkingdom; the relation of those sizes to the sizes of the species in the orders or families of Apyrenæmata and throughout the class of Birds; the essential difference between the Pyrenæmata and Apyrenæmata, with the conformity of the Lampreys to the former and of the Camels to the latter type, and the identity of the corpuscles in placental and implacental Mammalia. On some points the engraved page in the 'Proceedings of the Zoological Society,' Feb. 25, 1862, contains such errors of omission and commission, caused by strange accidents, and is so deficient in later observations, that it is now given with the needful corrections and additions in illustration of the present paper. Specimens of the corpuscles in the different classes and orders are all drawn side by side to a uniform scale, of which each one of its ten divisions stands for $\frac{1}{4000}$ of an English inch, and the whole length of the scale for $\frac{1}{400}$ of an inch. The same design will be adopted, with unimportant modifications in the arrangement of the corpuscles and divisions of the scale, in the next edition of Professor Beale's excellent work on the microscope. Historical notices of the observations of my predecessors and contemporaries are given in the memoirs cited above, and in the notes to the edition of Hewson's Works already mentioned.

The present Tables, though so extensive, show how numerous are the Vertebrates of which we still require an examination of the blood-corpuscles. The sum of the facts at this time known on the subject is so far imperfect, that we are ignorant of how soon new ones may turn up to subvert even our most cherished theories or generalizations. Hence the remarks or deductions on the present occasion, being confined to the measurements given in the Tables, must be considered as provisional, subject to modifications or corrections to suit the advance of knowledge, especially as regards Fishes, Batrachians, Cetaceans, Sirenians, and some other Vertebrates. It is desirable, too, that my measurements should be subjected to experimental examinations by independent observers.

To rigorous accuracy these Tables, of the averages of a far greater number of measurements, have no pretension. In this respect all that can be candidly said is, that, though they have been carefully deduced from innumerable and generally correct observations of the corpuscles, the size of these is by no means invariable in a single species, and that, even were they ever so constant in magnitude, seeing how much they usually differ among themselves in every field of vision, commonly to the extent of one third larger or smaller than the mean, their average dimensions could not be easily determined with sure precision. Upwards of a third of a century has passed since Dr. Bowerbank, experimenting with a cobweb micrometer at one of his delightful and instructive entertainments, found a remarkable difference in the size of the red blood-corpuscles obtained from the fingers of three gentlemen among his guests then present together. In the human subject I have often observed similar diversities, though to a less extent than appeared in Dr. Bowerbank's experiments; and I have notes of results to the like effect of observations, long since made by me, on single and on different individuals of one and the same species of all the Vertebrate classes. But such variations (in Man, see further p. 484), whether in a single individual or in different individuals of one species, are confined within such limits as not to prevent good approximations to the truth in the measurements.

It should also be borne in mind that small organisms, even when each of them has a fixed diameter, vary so much among themselves that it would be difficult, if not impossible, to determine with absolute precision their mean dimensions, however easy it may be to measure truly a single blood-disk or a spore of a cryptogam. For example, let any person make trials with several portions of one and the same sample of spores or little seeds of a plant, when the results of numerous true measurements will fail to afford precisely the same average diameter. How, then, can this be expected of objects so variable in size and shape as the red blood-corpuscles? Those of Mammalia, when dried slowly, are apt to become misshapen and more or less irregularly contracted; but when dried instantaneously in single or very thin layers on a glass slide, their form is admirably preserved, and their size is a shade larger than in the wet state, especially when prepared in summer. The pyrenæmatous corpuscles, on the contrary, are generally somewhat contracted by similar drying. The complete and permanent preservation of their form by drying seems to be a characteristic of the red blood-corpuscles; other soft bodies, such as lymph-corpuscles or pale blood-globules, lose their shape, however carefully dried. Of both kinds of the red corpuscles I have many specimens thus prepared more than a third of a century since, and they are still as beautifully perfect as ever, though they are naked, as at first, on the glass slides, protected only by wrapping paper, and have often travelled about, with military baggage and otherwise, both by sea and land. The blood prepared in this simple manner only requires to be kept dry. And thus it would be easy for voyagers to preserve and bring home specimens of red blood-corpuscles quite suitable for mensuration.

Special circumstances, too, of which we have not yet sufficient knowledge, may affect the value of any series of such measurements as those recorded in these Tables. When a bird is much excited, and the circulation quickened by attempts at its capture in an aviary, the oval figure of its red blood-corpuscles may be more elongated than in the same bird when quietly at rest. In Batrachians and Reptiles the corpuscles are so large as easily to admit of a perception of variations in their size; these I have found surprising in *Proteus* and *Sieboldia*; and my attention was sometimes arrested by like diversities in other Vertebrates at different times or seasons, though not in so many observations and with such notes as would be needful for satisfactory conclusions. But the facts are sufficient to show that exact and extensive investigations are yet necessary on the comparative magnitude of the red corpuscles, and their aggregate proportion to the other parts of the blood, in one and the same animal at different seasons and under various circumstances:—for example, whether minute diversities in the corpuscles may not be found in man at the tropics and frigid zone; in animals at rest and during violent exertion; in hibernating animals during winter and summer; in species subject to periodic increase of temperature, as observed by Dr. Sclater in the Python during incubation (Proc. Zool. Soc. 1862, p. 365, and 1870, p. 97); in males and females; in the arterial and venous systems, and in their different parts; also in relation to the ever-varying state of the liquor sanguinis. Such delicate inquiries, indeed, would require much care and labour, but might be rewarded with valuable results. Pathological or septic changes are out of the present question; but to it belongs the fact that in a single healthy species the corpuscles are so prone to minute variations of size that of these no two observers, or even one observer, can be certain of obtaining precisely the same average measurements.

No wonder, then, that those obtained by such an excellent micrographer as Dr. J. J. Woodward (Month. Micros. Journ., Feb. 1875) should not exactly agree with the results recorded by other observers. Nor need errors be suspected in measurements which differ little more than the objects measured, and which differences, though limited in degree, are sufficient to prevent an exact concordance in divers observations, especially as regards the mean sizes of the blood-disks.

Considering therefore all the fore-mentioned disturbing circumstances, perfect agreement and precision in measurements of the corpuscles, and deductions of completely unexceptional averages therefrom, by various observers, or even by one observer, will appear hopeless. Accordingly, as already hinted, my Tables cannot pretend to absolute exactness, and are only offered for what they may be worth ; and in the estimation of their value, allowance should be made for errors, whether instrumental or personal, more or less inevitable, notwithstanding the greatest care, in observations so extensive.

But the relative value of the measurements, though probably not unexceptionable, may be entitled to more confidence as fair approximations to the truth. They were all made by me, under the same conditions and by the same means as described in former papers ; and by any valid micrometry, in spite of little mistakes or of variations in the dimensions of the corpuscles of this or that species, the comparative results will appear sufficiently uniform. Thus, if we compare the red blood-corpuscles of species of one order or family, *e.g.* Tragules and other Ruminants, the corpuscles in the former animals will constantly prove the smallest—so, too, in *Paradoxurus* and *Canis*, in *Hippopotamus* and *Elephas*, in *Mus* and *Hydrochœrus*, in *Dasypus villosus* and *Orycteropus capensis*, in *Rhea americana* and *Casuarius javanicus*, in *Zootica vivipara* and *Anguis fragilis*, in *Bufo viridis* and *Bufo vulgaris*, in *Osmerus eperlanus* and *Salmo salar*. And in like manner the facts are equally clear in a comparison of the different orders ; so that the corpuscles are smaller in Ruminantia than in Rodentia, in Marsupiata than in Edentata, in Granivoræ than in Rapaces, in Anura than in Urodela, in Sturiones than in Plagiostomi.

Pyrenæmatous Vertebrates.

In every animal, without any known exception, of this great division the red blood-corpuscle is characterized by the presence of a nucleus, which is plainly demonstrable in the majority of the corpuscles when examined on the object-plate under the microscope. Nor is the taxonomic value of this fact at all affected by the old and still vexed question, as to whether the nucleus exists distinctly or at all in the corpuscle while it circulates within the living blood-vessels, or is formed only after its exposure to the atmosphere or chemical reagents. Many years ago De Blainville, Valentin, Henle, and others, and more recently Savory, supported the latter view ; and the former was adopted by Mayer and Kölliker, to which Brunke has lately conformed. The subject cannot be entertained here ; only it may be noted that I have satisfied myself of the substantial accuracy of Mr. Savory's observations on the blood-disks of some British Batrachians, but not of the validity of his conclusion therefrom, and that I have plainly seen in certain fishes the projections on the corpuscles, indicative of a nucleus, while they were flowing within the living blood-vessels.

In Pyrenæmata the thickness of each of the red blood-corpuscles is commonly about one third of its short diameter; they are oval, except in the Lampreys; largest in the tailed Batrachians and *Lepidosiren*; and then follow, in the order of the size of the corpuscles, Rays and Sharks, Frogs and Toads, Reptiles, Birds, and osseous Fishes, with certain exceptions, which may be seen in the Tables of Measurements. Among the oval corpuscles, whether in Pyrenæmata or Apyrenæmata, a few may deviate by gradations to the circular shape. Of these terms Pyrenæmata and Apyrenæmata, here applied to the two great sections of the Vertebrate subkingdom, an account is given in my Lectures cited above, also in the second volume of the 'Journal of Anatomy and Physiology,' in the 'Proceedings of the Zoological Society,' Feb. 25, 1862, and in the 'Hunterian Oration,' 1863.

Fishes.

In no other vertebrate class are the red blood-corpuscles so difficult to measure as in this, wherein they are prone to rapid septic conditions, are singularly delicate in outline and substance, and hence most liable to changes of shape; in all of which points the corpuscles of Fishes contrast remarkably with those of Reptiles and Birds.

Form of the corpuscles.—Throughout the Vertebrates this is a disk, like a cake or coin; and hence the term blood-disk; but it is never so thin proportionally as a coin, and in fishes the thickness is about one third of its short diameter. The corpuscles are circular in the Lampreys, as figured with details in the 'Proceedings of the Zoological Society,' Dec. 6, 1870, p. 845; but in all other fishes more or less oval, so far as we yet know. If we consider the short diameter of the corpuscle as 1, the long diameter will usually be between $1\frac{1}{8}$ and $1\frac{3}{4}$; and the nucleus has much the same figure, and is often nearly or quite globular. But these proportions are variable, since the corpuscles are frequently suboval; and in such cases several of them assume, by gradations, a circular shape, while those of the suboval form predominate. This may be plainly seen, for example, in the Anacanthini, especially a few hours after the death of the fish; and then, in other orders besides that, the corpuscles are apt to present angular, fusiform, lanceolate, crescentic, oat-shaped, and still more irregular forms, all of which commonly exist in the blood of Gadidæ and Clupeidæ obtained from fishmongers. In some Acanthopteri and Malacopteri, as *Scomber*, *Caranx*, *Lophius*, and *Salmo*, and the great Eels of Rodriguez, good examples occur of well-defined oval corpuscles. In the Pike most of them are somewhat pointed at the ends. In the osseous fishes there is generally, but not always, a rounded projection on each broad surface of the corpuscle, caused by the nucleus and a groove between it and the margin of the disk. And in no Pyrenæmata has the regular red corpuscle that concavity, gradually deepening towards the centre (Plate LV. fig. 2), which is characteristic of the regular corpuscle in Apyrenæmata, and has often been mistaken for a nucleus.

Size of the corpuscles.—In the osseous fishes the largest corpuscles are those of the Salmonidæ, as figured in the 'Proceedings of the Zoological Society,' Nov. 19, 1872, p. 835; but though this largeness is plain in *Salmo*, *Trutta*, and *Thymallus*, it disappears in

Osmerus, in which the corpuscles are much smaller than in certain Apodes. The smallest corpuscles occur in some of the little species of Acanthopteri and Anacanthini, and in the Sprat and Herring, while their congener the Pilchard has slightly larger corpuscles. They are somewhat larger in the river-Eels than in the Conger. In no single order of fishes are the corpuscles twice as large in one species as in another; they are quite as large in the osseous Salmon as in the cartilaginous Sturgeon, and in the Sharks and Rays so much larger as to adumbrate a distinct class. *Lepidosiren* has the corpuscles of such still greater magnitude as to depart in this respect from any regular fish to reach the saurobatrachian character.

Batrachians.

Form and size of the corpuscles.—On each broad surface they are generally flat or somewhat vaulted; and their outline is regularly a well-defined oval figure, mixed occasionally with a few of a suboval or even circular shape, as indeed is the case among all regularly elliptical blood-disks, though this is rarer in Birds than in the lower classes and in the Camels. In Batrachians, the short diameter of the corpuscle being taken as 1, its long diameter would vary commonly between $1\frac{1}{3}$ and $1\frac{3}{4}$. The thickness of the corpuscle is about one third of its short diameter; and the nucleus may be either subrotund, or more commonly liker in shape to the envelope. The largest red blood-corpuscles of Vertebrates occur in the tailed Batrachians, of which *Amphiuma*, a cauducibranchiate species, has the largest of all, so that these are visible to the naked eye, and the perennibranchiate *Proteus* the next in size; and in *Sieboldia*, which has deciduous gills, the corpuscles are larger than in *Siredon*, which has permanent gills. In *Amphiuma* and *Proteus* the corpuscles are at least thrice as large as in some Frogs and Toads—an amount of difference of which there is no example either in the class of Birds or Reptiles, though it is exceeded among Apyrenæmata. The corpuscles in the anurous Batrachians are not always bigger than, and sometimes not so long as, in a few reptiles and in some Sharks and Rays. The size of the corpuscles in Batrachians may differ in the same individual at different seasons. A few more observations on the corpuscles in this class are given in the 'Proceedings of the Zoological Society,' Feb. 4, 1873.

Reptiles.

Form and size of the corpuscles.—They are oval, flattish, little tumid on each broad surface—much of the same shape as, but generally rather longer in proportion to their breadth than, in Batrachians, as is the case, too, in some birds. And as in such elongated shape of the corpuscles in a few species (e. g. *Anguis fragilis* and *Crocodilus lucius, Syrnea nyctea* and *Columba migratoria*) Reptiles and Birds agree, so they differ from the other classes. Of Reptiles the largest corpuscles occur in some Crocodiles and Tortoises, and the smallest in the little Saurians and larger *Teius* and *Monitor*; the reptilian corpuscles are smaller than those of the batrachian Urodela, but in a few species longer, and in more smaller than in some of the Anura. Thus in most Tortoises and Crocodiles and the Slow-worm the corpuscles are longer than, though not so broad as, in the Green Tree-Frog and in some exotic Toads, but are smaller in *Python, Teius, Zootica, Lacerta, Plestiodon,* and *Iguana tuberculata* than in any Batrachians; and of this *Iguana,* which has the smallest known reptilian corpuscles, it is remarkable how much smaller they are than those of *Iguana cyclura.* Nor are the corpuscles in Reptiles, though regularly larger than in Birds and Osseous Fishes, ever quite so large as in Rays and Sharks; and in some Ophidians and Saurians the corpuscles are smaller than in certain Salmonidæ. There is more uniformity of the corpuscles throughout the class of Reptiles than in some single orders of Apyrenæmata; in no Reptile are the corpuscles twice the size of those in other reptiles, and the corpuscles are oval in every species. Here, again, there is a conformity of Birds to Reptiles, and a divergence of both these classes from Mammalia, each of those pyrenæmatous groups being in these respects more like an order than the class of Apyrenæmata. But Reptiles, unlike Birds, present no relation between the size of the corpuscles and that of the species; they are as large in the little Viper and Snake as in the huge Pythons and Boa, and in the small *Anguis* and *Chamæleon* as in the large *Teius* and *Monitor.* Differences in the size of the corpuscles probably occur at certain seasons.

Birds.

Form and size of the corpuscles.—They are oval in all birds, generally flat, with a slight tendency to be gibbous on the broad surfaces, altogether of much the same shape as in reptiles; taking the short diameter of the avian corpuscles as unity, the long diameter would usually vary between $1\frac{1}{2}$ and 2. But, as in Reptiles so in Birds, there are remarkable deviations from the regular proportions; thus, *e. g.*, in *Columba migratoria* (fig. 60), *Lanius excubitor* (fig. 56), and *Syrnea nyctea* (fig. 58) the length exceeds twice the breadth of the corpuscles, while in *Columba rufina* (fig. 59) and a few more pigeons, *Dolichonyx oryzivorus* (fig. 61), in species of *Loxia* and certain other Granivoræ, the corpuscles have a much shorter oval figure. A mere glance at the Tables of Measurements will show how nearly the short diameters of the blood-disks of Birds agree with the diameters of the blood-disks in Apyrenæmata; so that there is no bird in which such coincidence with some mammals is not obvious.

Regularly the nucleus is more oblong than the entire corpuscle, so that the length of the nucleus is about twice, and occasionally nearly or quite thrice, its breadth. Hence this elongated shape exceeds that of the corresponding nucleus of other Pyrenæmata, and is characteristic of Birds; but there are exceptions, as may be seen in some gallinaceous species, in which the nucleus is suboval or nearly globular.

Though in Birds the red corpuscles are regularly smaller than those of Reptiles, a few exceptions occur; for example, the corpuscles are quite as large in the Cassowaries as in certain Saurians. And while

Birds almost always have the corpuscles larger than those of Mammalia, here, too, are a few irregularities, as will appear on a comparison of the corpuscles of *Linaria, Dolichonyx* (fig. 61), and *Trochilus* (fig. 66) with the largest apyrenæmatous corpuscles (figs. 14, 23, and 47). In Birds the largest corpuscles belong to the Cursores (fig. 53), the next in size to the Rapaces (fig. 58), Palmipedes (fig. 65), Grallatores, and the Hornbill (fig. 62); the smallest corpuscles occur in some of the little Granivoræ (fig. 61) and Insectivoræ, in the Humming-bird (fig. 66) and other Anisodactyli. Throughout the class of Birds there is so far a relation between the size of the species and the size of the corpuscles, that no instance is known of the largest corpuscles in the small species, or the smallest corpuscles in the large species. And herein this entire class rather resembles an order or family than the class of Mammalia; and so, too, as regards the constant oval figure of the avian corpuscles. In some single apyrenæmatous orders there are greater diversities in the size, and in a few instances in the shape, of the corpuscles than in the entire class either of Birds or Reptiles; in neither of these two pyrenæmatous classes is there any exception to the elliptical form of the corpuscles, nor are the corpuscles ever twice as large in one species as in another of the same class.

Apyrenæmatous Vertebrates.

As already described, in all the oviparous or pyrenæmatous Vertebrates there is a nucleus distinctly demonstrable in the red corpuscles. And now we come to the Mammalia or Apyrenæmata, in which, on the contrary, no such nuclei can be made visible by the very same treatment which plainly displays them in the Pyrenæmata; that is to say, a nucleus cannot be disclosed in the majority of the red blood-corpuscles of Apyrenæmata. The oval blood-disks of the Camels (figs. 37–41) conform in this respect, and in smallness of size, to the circular corpuscles of other Apyrenæmata; in no pyrenæmatous vertebrate are the corpuscles so small as in the Camels. Of course we are not dealing now with the large temporary red corpuscles which have nuclei in the early mammalian embryo, nor with phases of development and decay in the adult, but with the majority of the regular corpuscles. Neither are we concerned with Mr. Wharton Jones's valid doctrine as to their origin, nor with any speculations as to their real nature. So far as is yet known this is peculiar; for the free apyrenæmatous corpuscles have no known homologue, and are devoid of the true characters of nuclei.

Form of the corpuscles.—This is regularly a circular biconcave disk (figs. 1 and 2), the concavities very shallow and deepening towards the centre; and this is characteristic of Apyrenæmata. At the circumference the thickness is between a third and a fourth of the diameter of the corpuscle. But a body so soft, so readily affected by osmosis and other causes, is liable to assume many odd shapes which may be seen to occur during the examination. Thus appear such forms as plano-convex, biconvex, crenate, puckered, granulated, dinted, cup-shaped, and several others. Sometimes their circumference is swollen, so as to produce triangular, oval, or formless pits towards the centre. In the Tables of Measurements only the regular blood-disks are noted. Of the Apyrenæmata the Camels (figs. 37–41) alone have oval red blood-corpuscles; but these, as before mentioned, conform in all other respects to the apyrenæmatous type; and a few subrotund or circular disks may occur among the prevailing oval ones. In some Cervidæ the corpuscles (fig. 42) assume fusiform, lanceolate, crescentic, and irregularly polygonal and other angular forms, as originally figured on page 329 of the 'London and Edinburgh Philosophical Magazine,' Nov. 1840; but with these are mixed a few red corpuscles of the usual circularity, which only were measured for the Tables.

Size of the corpuscles.—They are the smallest in the vertebrate subkingdom; and the smallest of all occur in the Ruminants (figs. 29–34), especially in the Tragulidæ (figs. 29–31); and thus this family may be distinguished from all other Vertebrates, not even excepting *Moschus* (Proc. Zool. Soc., Feb. 10, 1870, fig. 2), which was formerly confounded with *Tragulus*, and of which the anatomy has been described by Professor Flower in the 'Proc. Zool. Soc.' March 16, 1875. Comparative views of the corpuscles of these two genera are engraved to a scale in the same 'Proceedings,' Feb. 10, 1870. Since then, using Powell and Lealand's $\frac{1}{16}$ objective, I could detect no difference between these red blood-corpuscles of *Moschus moschiferus* and *Cervus nemorivagus* (fig. 32), while the comparative smallness of those of *Tragulus* (figs. 29–31) was remarkable and significant. The largest corpuscles in the class belong to the Elephants (fig. 23), great Edentates (fig. 47), and pinniped Feræ (fig. 14); in some of which, as the Walrus (fig. 14), the Elephants (fig. 23), the Great Anteater (fig. 47), the Two-toed Sloth (fig. 48), and the Ardvark (Proc. Zool. Soc., Feb. 10, 1870, fig. 4), the corpuscles are as large as in a few Birds (figs. 61 and 66). The Monotremata (fig. 52), Marsupialia (figs. 50 and 51), and Rodentia (figs. 43–46) have somewhat large corpuscles, which in some Cetacea (fig. 20) are larger. Sometimes two sets of corpuscles occur in nearly equal proportions, one set about a third smaller than the other; this fact, though rare in most mammals, is not uncommon in the Squirrels. Of the Pachydermata the Elephants alone have the corpuscles larger than those of Man, and the smallest occur in the Horse (fig. 26); their comparative largeness in such a small species as *Hyrax* (fig. 28) proclaims it, though arranged here, but an irregular member of this order.

In the Feræ or Carnivora there are great irregularities: while some of the largest apyrenæmatous corpuscles occur in this order, they are in many of its species smaller than in several Ruminantia. The families of Carnivora, according to the sizes of their red blood-corpuscles, would stand thus:—Seals (fig. 14), Dogs (fig. 15), Bears (fig. 11), Weasels (fig. 16), Cats (fig. 17), Viverras, Paradoxures (figs. 18 and 19). These sizes differ so much that by them alone Seals or Dogs may be easily distinguished from Viverras or Paradoxures; while the same kind of diagnosis would be difficult, unless under the most favourable circumstances, and in some cases impossible, between members of the first two families and Man. In the largeness of the corpuscles the Hyænas are more like Dogs than Viverras. The Fox has the corpuscles smaller than those of the common Dog and Dingo (fig. 15). *Cercoleptes* (fig. 13) in the smallness of the corpuscles resembles a *Viverra,* thus hardly appearing to be a regular member of Plantigrada or Ursidæ; but, on the other hand, I have found the muscular sheath of the œsophagus (Proc. Zool. Soc., May 12, 1870) of *Cercoleptes* more like that of a Bear than of a Civet. *Bassaris* (fig. 12) in the size of its corpuscles agrees with the Ursidæ and differs from the Viverridæ. Of the Insectivora (fig. 10), excepting the curious and surprising deviation in *Sorex indicus,* the corpuscles are somewhat smaller than those of Plantigrada (fig. 11). In that species the corpuscles are hardly, if at all, distinguishable from those of Man, as was shown to me by my son, who brought the blood from the Mauritius. In that country this Shrew is called the Musk-Rat, and, as it is very common, the fact of the size of its red blood-corpuscles might become one of the many objections to the identification by micrometry of human blood-stains. In the Bats (figs. 7–9) the corpuscles are just appreciably larger in the frugivorous than in the insectivorous species. In the Monkeys (figs. 4 and 5) the corpuscles are somewhat larger still, with a tendency to a diminution of size in the Lemurs (fig. 6), but generally so nearly approaching in the higher species to the human corpuscles as to be scarcely distinguishable therefrom.

In Man (figs. 1 and 2) the red blood-corpuscles are not always distinguishable from those of the Dog, but are regularly larger than in any British land Mammals, and are not known to be exceeded in size in more than eight or nine foreign species of this class, though closely approximated, or even surpassed, in some Marsupials, Edentates, Rodents, Cetaceans, Feræ, and most Monkeys. As before noticed (p. 476), the magnitude of the corpuscles in a single species, not excepting the human, is liable to variations within certain limits; and there commonly appear in one field of vision of the same corpuscles differences amounting to at least one third larger and smaller than the average. Hence as regards the medico-legal question, however truly a careful observer (Dr. Joseph G. Richardson, Month. Micros. Journ., Sept. 1874) may have distinguished, by comparative measurements of the corpuscles, stains of human blood from those of the Sheep or Ox, this kind of diagnosis, as Dr. J. J. Woodward observes (Month. Micros. Journ., Feb. 1875), would be ineffectual in some probable and more possible cases (see before at p. 477). It should be borne in mind, too, that in the Apyrenæmata the membranous bases (fig. 3) of the blood-disks, when deprived of their colour by maceration in water, are about a third smaller than the unaltered corpuscles.

Much larger red blood-corpuscles than those of the human species may be expected in the most gigantic marine Feræ and Cetacea. The largeness of the corpuscles in *Orycteropus* was truly predicted long before they were ever examined; and we may well suppose that they were larger in the huge extinct Edentates than in any existing

Mammal. It would be very interesting and probably instructive to examine the corpuscles of the Sirenia.

Reverting summarily to a few points throughout the whole apyrenæmatous class, we shall find several plain facts which, though long since demonstrated, are still ignored in the current treatises of comparative anatomy and histology. For example, while the smallest corpuscles occur in the Ruminants, there are some species of this order in which the corpuscles are larger than in certain Feræ; the Edentates, on the other hand, are eminently characterized by the largeness of the corpuscles; commonly the diameters of the apyrenæmatous corpuscles agree remarkably with the short diameters of the corpuscles in Birds. The corpuscles in a few Apyrenæmata are five times as large as in others; and even in the single order of Ruminants the corpuscles, besides aberrations in their shape, are thrice as large in several Cervidæ and Bovidæ (fig. 35) as in some Tragulidæ (figs. 29 and 30). In the Feræ the corpuscles are more than twice as large in some species as in others, in this order the largest corpuscles (fig. 14) being larger than those of Man (fig. 1), and the smallest (figs. 18 and 19) smaller than in some Ruminants (figs. 35 and 36). Hence, on the whole, there are greater diversities in the size of the corpuscles than in any other class; so that in this point of view a single apyrenæmatous order would appear equal to an entire class either of Birds or Reptiles, and each of these two pyrenæmatous classes only equivalent to an order of Mammalia. But comparing the largest with the smallest batrachian corpuscles, and those of *Lepidosiren* and some Rays and Sharks with the smallest corpuscles in osseous fishes, differences of size appear almost or quite as great as in Apyrenæmata.

From this class selections might be and have been made to show that there is no relation between the size of the species and the size of the corpuscles. These are quite as large in the tiny Harvest-Mouse (fig. 46) and Shrew (fig. 10) as in the great Giraffe (fig. 36) and Horse (fig. 26). But if, instead of thus comparing such widely different animals, and excepting some little irregularities already noticed, we confine the observations to small natural groups of the class, such a relation will plainly appear in a rule that the largest corpuscles occur in the large species and the smallest corpuscles in the small species of a single order or family. This relation is well shown by the Ruminants, Rodents, and Edentates; and even in the Feræ, which offer some exceptions, the largest corpuscles are found in the big Seals (fig. 14), and the smallest corpuscles in the little Viverras and Paradoxures (figs. 18 and 19). In fine, though this rule is applicable only to single orders or lower sections of Apyrenæmata, it extends to the whole class of Birds, but neither to Reptiles, Batrachians, nor Fishes, except in some partial instances, which seem to be rather indeterminate or accidental than regular.

In the following Tables the measurements are all in vulgar fractions of an English inch, and express only the average diameters of the red blood-corpuscles or their nuclei. The numerator, being invariably 1, is omitted throughout, and the denominators only are printed. Of the corpuscles the long diameter is denoted by L.D., the short diameter by S.D., and the thickness by T.

VERTEBRATA PYRENÆMATA.

PISCES.

CYCLOSTOMI.

Petromyzon fluviatilis......	2134
T.	6200
Nucleus	6400
„ marinus	2134
„ planeri........	2134
Ammocœtes branchialis	2134

MALACOPTERI.

Apodes.

	L.D.	S.D.
Gymnotus electricus ..	1745	2599
Anguilla vulgaris	1745	2842
„ marmorata ..	1895	2900
„ amblyodon ..	1777	3000
Conger vulgaris	2286	3000
Ammodytes lancea....	2000	3555

Abdominales.

	L.D.	S.D.
Clupea sprattus	2666	3555
„ harengus	2666	3555
„ alba	2666	3555
„ pilchardus	2286	3200
Engraulis encrasicholus	2286	3000
Alosa finta	2286	3000
T. 8888		
Salmo salar..........	1524	2460
„ ferox	1524	2900
„ fario..........	1524	2900
T. 8000		
„ fontinalis......	1455	2286
Thymallus vulgaris ..	1684	2900
Osmerus eperlanus....	2286	3000
T. 8888		
Nucleus	6400	8888
Esox lucius..........	2000	3555
Nucleus	5333	8000
Belone vulgaris	2286	3000
Cobitis barbatula	2286	3200
Cyprinus carpio	2142	3429
T. 8000		
Nucleus	6400	8000
„ tinca	1895	2400
T. 8000		
Nucleus	8000	9600
„ auratus	1777	2824
T. 10666		
„ brama......	2400	3555
„ erythrophthalmus......	2000	3200

	L.D.	S.D.
Cyprinus rutilus......	2133	3000
„ phoxinus....	2000	2900
„ cephalus	2133	3555
„ gobio	2133	2900

ANACANTHINI.

	L.D.	S.D.
Gadus morrhua	2133	3555
„ æglefinus......	2460	3200
„ luscus	2460	3200
Merlangus carbonarius.	2133	3000
„ vulgaris ..	2460	3555
Merluccius vulgaris ..	2133	3000
Motella mustela......	2400	3200
Platessa flesus	2666	3000
„ vulgaris......	2666	3000
„ limanda......	2900	3200
Pleuronectes rhombus.	2460	3200
Solea vulgaris........	2400	3200

ACANTHOPTERI.

	L.D.	S.D.
Perca fluviatilis......	2099	2824
T. 8700		
Nucleus	7482	8830
„ marina........	2960	4000
„ labrax	2666	3200
„ cernua	2461	3000
T. 8000		
Nucleus	6000	8000
Dules, sp.	2400	2900
Sparus centrodontus ..	2286	3200
Mullus surmuletus....	2286	3000
„ barbatus......	2286	3200
Trachinus draco	2400	3000
Mugil capito	2400	3200
Scomber scomber	2286	3200
Thynnus communis ..	1600	2666
„ pylamides ..	2000	3000
Zeus faber	2000	2666
Caranx trachurus	2000	3555
Xyphias gladius......	2461	4008
Trigla hirundo	2666	3555
„ cuculus	2460	3200
„ gurnardus	2286	3000
Cottus gobio	2000	2900
T. 8000		
„ bubalis	2000	2900
„ scorpius	2000	2900
Gasterosteus leiurus ..	2666	3000

	L.D.	S.D.
Gasterosteus pungitius	2666	3000
Gunellus vulgaris	2460	3000
Blennius pholis	2460	3000
Callionymus lyra	2286	3000
Lophius piscatorius ..	1895	2666
T. 8000		
Cyclopterus lumpus ..	2000	2666
Lophobranchii.		
Syngnathus typhle....	2286	2666
Plectognathi.		
Diodon, sp.	2286	3000
Ganoidei.		
Acipenser sturio......	1600	2666
Plagiostomi.		
Selachii.		
Spinax acanthias	1148	1600
Nucleus	3000	4000
Fœtus	1000	1333

	L.D.	S.D.
Squalus centrina	800	1000
Scyllium canicula	1000	1542
Nucleus	3000	4000
„ stellaris	1000	1777
Zygæma, sp.	1185	1777
Lamna cornubica	923	1500
Mustela lævis........	1090	1500
Squatina angelus	1032	1455
Fœtus	1000	1333
Batides.		
Torpedo oculata......	800	1000
Raia batis	970	1455
„ clavata	1090	1600
Protopteri.		
Lepidosiren annectens.	570	941
Nucleus	1455	2900

BATRACHIA.

	L.D.	S.D.
Amphiuma tridactylum	363	615
Nucleus	1143	2000
Proteus anguinus	400	727
Nucleus	1600	2666
Siren lacertina	420	760
Nucleus	1142	2007
Menopoma alleghaniense	563	1000
Nucleus	1333	2286
Siredon humboltii	571	1000
Nucleus	2000	3000
Sieboldia maxima	450	800
Triton bibronii	848	1280
Nucleus	1901	3000
„ cristatus	848	1280

	L.D.	S.D.
Lissotriton punctatus..	800	1280
Nucleus	1778	2667
Rana temporaria	1108	1821
T. 7112		
Nucleus	3114	6297
„ Tadpole ($\frac{1}{2}$ in. long)	1098	1650
„ esculenta	1000	1445
Hyla viridis..........	1391	1895
Pelodryas cæruleus ..	1280	2000
Bufo vulgaris	1043	2000
T. 5627		
Nucleus	2802	5261
„ viridis..........	1333	1895
„ calamita........	1333	1895
Bombinator igneus ..	1333	1895

REPTILIA.

	L.D.	S.D.
Ophidia.		
Coluber berus........	1274	1800
Nucleus	3227	4986
Heterodon madagascariensis	1455	2460
Coronella phocarum ..	1455	2286
Eryx johnii..........	1455	2286
Natrix torquata	1371	2157
T. 8341		
Nucleus	3835	6817
Boa constrictor	1440	2400
Python sebæ	1440	2400
„ regius........	1440	2400
„ tigris	1440	2400
Nucleus	3555	7468

	L.D.	S.D.
Morelia (?) spilotes ..	1545	2400
„ argus	1371	1685
Cœlopeltis lacertina ..	1500	2400
Chilobothrus inornatus	1391	2286
Sauria.		
Anguis fragilis	1231	2666
Euprepes australis	1524	2666
Pseudopus pallasii	1524	2460
Zootoca vivipara	1600	2460
Lacerta viridis	1555	2743
Teius teguexin	1455	2666
Monitor niloticus	1524	2666
Iguana tuberculata....	1600	2900
„ cyclura	1230	2285
Nucleus	5333	6400

	L.D.	S.D.
Chamæleon vulgaris	1391	2400
Gecko ——?	1333	2133
Trachidosaurus rugosus	1391	2900
Plestiodon auratus	1455	2400
Champsa fissipes	1259	2315
Alligator ——?	1324	2122
Crocodilus acutus	1231	2286
T. 8000		
„ lucius	1124	2215
Chelonia.		
Emys caspica	1143	2000
Emys trijuga	1333	1909
Chelonia mydas	1231	1882
Nucleus	4000	6000
Testudo græca	1252	2216
„ radiata	1241	2197
„ mauritanica	1280	2000
„ tabulata	1143	2000
Gymnopodus ægyptiacus	1143	2000

AVES.

	L.D.	S.D.
Palmipedes.		
Phalacrocorax carbo	2005	3765
Pelecanus onocrotalus	1777	3369
Nucleus	3200	9600
Larus ridibundus	2097	4000
„ canus	1973	3839
Nucleus	3555	10666
Somateria mollissima	2000	3200
Anas galericulata	1937	3424
Querquedula crecca	2062	4592
„ acuta	1993	3839
„ circia	2088	3839
Mareca penelope	1873	4385
Tadorna vulpanser	1925	3839
Dendronessa sponsa	2001	4079
Dendrocygna viduata	1789	3555
„ autumnalis	1916	3764
„ arborea	1931	3724
Cygnus atratus	1806	3692
Bernicla magellanica	1866	3839
„ sandivensis	1866	3839
Cereopsis novæ hollandiæ	1722	3692
Chenalopex ægyptiaca	1866	3839
Pinnatipedes.		
Podiceps minor	2001	3200
Fulica atra	1895	3200
Grallatores.		
Gallinula chlorophus	2055	3839
„ porzana	2000	3555
Rallus philippinensis	2097	3389
Scolopax gallinago	2170	3622
Limosa melanura	1937	3764
Numenius phæops	1846	4465
Ibis ruber	1948	3153
Platalea leucorodia	1859	3600
Ciconia alba	1755	3439
„ nigra	1806	3403
Ciconia argala	1728	3555
„ marabou	1859	3460
Ardea cinerea	1913	3491
„ nycticorax	1780	3555
„ minuta	1993	3827
Balearica regulorum	1858	3478
„ pavonina	1859	3777
T. 9597		
Nucleus	4000	9750
Anthropoides virgo	1884	3740
T. 11230		
„ stanleyanus	1909	3529
Psophia crepitans	1883	3488
Hæmatophus ostralegus	1895	4000
Nucleus	3200	9000
Vanellus cristatus	1964	3310
Œdicnemus crepitans	2157	4000
Dicholophus cristatus	1884	3364
Cursores.		
Otis tarda	1811	3200
„ houbara	1811	3200
Casuarius emu	1455	2800
„ javanicus	1455	2800
Dromaius novæ hollandiæ	1690	3031
Rhea americana	1898	3273
Struthio camelus	1649	3000
T. 9166		
Nucleus	3200	9166
Gallinæ.		
Tinamus rufescens	1752	3338
Tetrao urogallus	2248	3836
„ tetrix	2376	3728
„ caucasica	1923	3456
Nucleus	4570	9166
Ortyx virginianus	2213	4000
„ neoxenus	2305	3836
Coturnix argoondah	2347	3470

	L.D.	S.D.
Perdix longirostris ..	2054	3801
„ bonhami	1933	3282
Nucleus	4570	10666
Francolinus vulgaris .	2106	4041
Numida rendalli	2054	4415
Meleagris gallopavo..	2045	3598
Gallus domesticus ..	2102	3466
Nucleus	6400	8000
Phasianus pictus	2213	3615
„ nycthemerus	1887	3470
Nucleus	4000	8000
„ superbus ..	2128	3587
„ lineatus ..	1855	3488
Nucleus	4570	9166
„ colchicus ..	2168	3646
Nucleus	5647	7111
Pavo cristatus	1835	3589
„ muticus	1835	3589
„ javanicus......	1884	3491
Ourax mitu	2005	3490
Crax globicera	1985	3425
„ rubra	1993	3664
„ yarrellii	2000	3456
Penelope cristata	1902	3607
„ leucolophus	1902	3607
Nucleus	3555	9166
Columbæ.		
Columba mystacea ..	2100	3512
„ leucocephala	2132	3646
„ coronata ..	1954	3491
„ migratoria..	1909	4626
„ zenaida	2203	3571
„ montana ..	2239	3692
Nucleus	5333	12000
„ aurita	2322	3519
„ corensis....	2193	3643
„ guinea	2165	3839
„ nicobarica..	2133	3692
„ chalcoptera.	2208	4062
„ rufina	2314	3429
„ tigrina	2088	3615
„ turtur	2005	3369
„ risoria	2133	3523
„ palumbus ..	1973	3643
Chelidones.		
Cypselus apus	1982	3850
Nucleus	4000	10666
Hirundo rustica	2133	4000
Nucleus	4570	8000
„ urbica......	2170	4000
Podargus cuvieri	1834	3200
Alcyones.		
Alcedo ispida	2124	3693
Dacelo gigantea	2110	3555

Anisodactyli.

	L.D.	S.D.
Certhia familiaris....	2305	4000
Sitta europæa	2213	4188
Nucleus	4572	11000
Trochilus, sp.	2660	4000
Zygodactyli.		
Picus minor	2170	3892
Psittacula pullaria ..	2097	4174
„ cana	2101	4174
Psittacus mitratus ..	2029	3892
„ melanocephalus ..	2005	3892
„ menstruus..	2115	3708
„ badiceps ..	2165	3617
„ leucocephalus	2050	3727
„ amazonicus.	1800	3832
„ dufresnii ..	2278	3374
„ regulus....	2037	3764
„ americanus .	2115	3600
„ augustus ..	2085	3606
„ albifrons ..	1931	3692
„ erithacus ..	1898	4000
Tanygnathus macrorhynchus	2106	3829
Lorius domicellus ..	2093	4133
„ ceramensis ..	2115	4000
„ amboynensis..	2045	4133
„ coccineus	2165	4000
„ sinensis	2115	3692
Palæornis alexandri..	2115	3892
„ torquatus..	2174	3892
„ bengalensis	2278	4000
Trichoglossus capistratus	2203	3892
Psittacara virescens ..	2097	4175
„ solstitialis .	2133	4000
„ viridissima	2029	4190
„ patachonica	2155	3977
„ murina....	2133	4031
„ leptorhyncha	2067	3931
Nymphicus novæ hollandiæ	2160	4174
Platycercus niger	2133	3892
„ scapulatus	2000	4042
„ vasa	2045	3892
„ flaviventris	2118	3892
„ eximius..	2193	3892
„ pacificus..	2118	4174
„ pennanti .	2106	3931
Macrocercus severus..	2165	3801
„ macao ..	1902	4762
„ ararauna..	1961	4128
„ illigeri ..	1924	4335

	L.D.	S.D.
Macrocercus aracanga	1902	4041
Plictolophus eos	1981	3728
„ sulphureus	2203	3399
„ rosaceus..	1842	3547
Nucleus	4000	12000
„ galeritus .	1880	3600
„ phillipina-rum ..	1974	4041
Cuculus canorus	2028	3600
Corythaix buffonii ..	1902	3764

Granivoræ.

Vidua paradisea	1998	3740
Nucleus	3555	10666
Loxia malacca	2359	4167
„ cærulea	2290	3740
„ astrild........	2273	4740
„ javensis	2286	3677
„ enucleator	2247	4083
„ curvirostra....	2365	4000
„ coccothraustes .	2042	3790
T. 9141		
Nucleus	4570	10666
Plectrophanes nivalis.	2133	4740
Emberiza citrinella ..	2286	4000
Nucleus	4000	12000
„ cristata....	2310	4167
Alauda arvensis	2125	4128
Nucleus	4000	12000
Parus cæruleus......	2313	4128
„ caudatus......	2136	4570
Nucleus	4800	10666
„ major	2133	3892
Fringilla linaria	2286	4570
„ cannabina ..	2341	3768
„ cœlebs	2253	4133
„ spinus	2140	4000
„ chloris	2232	3600
„ canaria	2232	3600
„ amadava ..	2243	4800
„ carduelis ..	2243	4800
„ cyanea	2144	3741
Pyrgita domestica ..	2140	3500
Nucleus	4364	9200
„ simplex	2273	4000
Amadina fasciata....	2001	4364
„ punctularia.	2133	4133
Cardinalis cucullata..	2140	3643
„ dominicana	2140	3643
Ploceus textor	2213	4575
Dolichonyx oryzivorus	2400	4167

Insectivoræ.

Vanga destructor....	2019	3892
Lanius excubitor	1989	5325
„ collurio......	2230	3878

	L.D.	S.D.
Muscicapa grisola....	2179	4173
Orpheus polyglottus..	2223	3732
„ rufus	2231	3646
Merula vulgaris	2097	4256
Nucleus	5333	9140
Turdus canorus......	2305	3892
„ migratorius ..	2348	4133
„ musicus......	2203	4133
Nucleus	4000	9600
„ viscivorus....	2247	4000
Accentor modularis ..	2342	4000
Erithacus rubecula ..	2305	4133
Curruca atricapilla ..	2359	4133
Philomela luscinia ..	1895	4400
Nucleus	4000	12000
Sylvia phragmites ..	2003	3550
Motacilla alba	2182	3600
Nucleus	4000	10666
Regulus cristatus....	2284	4133
Troglodytes europæus	2359	4133

Omnivoræ.

Buceros rhinoceros ..	1690	3230
Toccus melanoleucus .	2000	3200
Molothrus sericeus ..	2133	4567
Coracias garrula	2000	3478
Sturnus vulgaris	2115	3892
Nucleus	3764	11333
„ prædatorius..	3133	4175
Pastor roseus	2106	4630
„ cristatellus ..	2133	4050
„ tristis........	1993	4167
Fregilus graculus....	2106	4505
Gracula religiosa	2075	4167
Corvus corax........	1961	4000
„ frugilegus....	1894	3196
Nucleus	4572	9140
„ monedula	2243	4167
Nucleus	4000	10665
„ pica	1953	3365
T. 11600		
Nucleus	4245	11138
Nucifraga caryocatactes	1875	4172
Garrulus pileatus....	2041	4167
„ cristatus ..	2041	3512
„ glandarius..	2064	3878
Nucleus	4000	10666
Ampelis garrula	2133	4000
Barita tibicen	2118	3892
Cracticus hypoleucus .	2116	4000

Rapaces.

Strix flammea	1882	3740
Nucleus	4000	10666
„ passerina	1885	3555

	L.D.	S.D.
Bubo maximus	1720	3566
„ virginianus	1837	4000
Syrnium aluco	1930	3801
„ nebulosum	1895	3200
Otus brachyotus	1763	4076
„ vulgaris	1830	3400
Surnia nyctea	1555	4042
Nucleus	3200	10666
Gypogeranus serpentarius	1722	3301
Milvus vulgaris	1931	3677
Falco peregrinus	1916	3862
„ tinnunculus	1891	3490
„ subbuteo	1827	3507
„ rufipes	2000	3790
„ nisus	2000	3555
Nucleus	3200	9166
Haliaëtus albicilla	1829	3390
„ leucocephalus	1909	3390

	L.D.	S.D.
Haliaëtus aguia	1806	3585
Helotarsus typicus	1891	3461
Aquila chrysaëtos	1812	3832
„ bonelli	1866	3598
„ fucosa	1852	3485
„ choka	1830	3691
Buteo vulgaris	1852	3691
„ lagopus	1852	3691
Polyborus vulgaris	1829	3572
Vultur auricularis	1835	3461
Nucleus	4000	10666
„ fulvus	1829	3399
T.	9600	
„ kolbii	1794	3337
„ leuconotus	1806	3425
„ angolensis	1684	3166
Sarcorhamphus papa	1825	3600
„ gryphus	1761	3892
Cathartes iota	1880	3691
Gypaëtus barbatus	1913	3425

VERTEBRATA APYRENÆMATA

seu

MAMMALIA.

Monotremata.

Echidna histrix	3840

Marsupiata.

Phascolomys wombat	3456
Petaurista sciureus	3661
Phalangista vulpina	3617
„ nana	3856
„ fuliginosa	3688
Halmaturus billardieri	3623
Macropus bennettii	3535
„ ocydromus	3442
„ giganteus	3330
„ derbyanus	3405
T.	10910
Dendrolagus inustus	3450
Hypsiprymnus setosus	4000
Perameles lagotis	3902
Dasyurus viverrinus	4056
„ maugei	4034
„ ursinus	3534
T.	10910
Didelphys cancrivora	3436
„ virginiana	3557
T.	12000

Edentata.

Myrmecophaga jubata	2769
Orycteropus capensis	2769
Dasypus sexcinctus	3457
„ villosus	3315
Bradypus didactylus	2865
„ „ juv.	2778

Rodentia.

Lepus timidus	3560
„ cuniculus	3607
Hydrochœrus capybara	3190
Cœlogenys subniger	3481
Dasyprocta aurata	3857
„ acouchi	3777
Cavia cobaya	3538
Castor fiber	3325
Myopotamus coypus	3355
T.	10667
Capromys fournieri	3483
Cercolabes prehensilis	3444
Erethizon dorsatum	3380
Hystrix cristata	3369
Ondatra zibethica	3550
Arvicola amphibius	3790
„ riparius	4199
Mus giganteus	3892
„ decumanus	3911
„ rattus	3754
„ musculus	3814
„ sylvaticus	3839
„ alexandrinus	3900

Mus messorius		4268
Dipus ægyptius		4172
Arctomys pruinosus		3484
„ empetra		3503
Sciurus vulgaris		4000
„ niger		3841
„ maximus		3633
„ cinereus		4000
„ capistratus		3930
„ palmarum		3847
„ listeri		3948
Pteromys nitidus		3777
„ volucella		3892

RUMINANTIA.

Auchenia vicugna	L.D.	3555
	S.D.	6444
„ paco	L.D.	3361
	S.D.	6294
„ glama	L.D.	3361
	S.D.	6294
Camelus bactrianus	L.D.	3123
	S.D.	5876
	T.	15210
„ dromedarius	L.D.	3254
	S.D.	5921
	T.	15337
Tragulus javanicus		12325
„ meminna		12325
„ stanleyanus		10825
Moschus moschiferus		7060
Cervus nemorivagus		7060
„ nov. sp.		7125
„ wapiti		4138
„ hippelaphus		3777
„ axis		5088
„ dama		4515
Fœtus (5 in. long)		3478
„ alces		3938
„ barbarus		4800
„ elaphus		4324
„ macrurus?		5074
„ mexicanus		5175
„ maral		4978
„ porcinus		5391
„ reevesii		6330
„ capreolus		5184
„ virginianus		5036
Camelopardalis giraffa		4571
Antilope cervicapra		5108
„ dorcas		4922
	T.	16000
„ gnu		4800
„ sing-sing		5150
„ philantomba		5116
„ picta		4875
„ bubalis		5600
Capra caucasica		7045
„ hircus		6366
„ hircus, var.		6430
Ovis musimon		5045
„ aries		5300
„ tragelaphus		6355
Bos taurus		4267
„ taurus, var.		4571
„ bison		4062
„ urus		4070
„ bubalus		4586
	T.	14000
„ caffer		4703
„ frontalis		4299
„ sylhetanus		4222

PACHYDERMATA.

Sus babyrussa		4316
„ scrofa		4230
Dicotyles torquatus		4490
Tapirus indicus		4000
Elephas indicus		2745
„ africanus		2745
Hippopotamus amphibius		3429
Rhinoceros indicus		3765
Equus caballus		4600
	T.	13422
„ asinus		4000
„ burchellii		4360
„ hemionus		4421
Hyrax capensis		3308

CETACEA.

Delphinus phocæna		3829
„ globiceps		3200
Balæna boops		3099

CARNIVORA.

Paradoxurus leucomystax		4236
„ bondar		5693
„ typus		5693
„ binotatus		4660
„ pallasii		5485
Otocyon lalandii		3600
Canis familiaris		3542
„ dingo		3395
„ vulpes		4177
„ bengalensis		3338
„ fulvus		3920
„ argentatus		3888
„ lagopus		3888
„ cinereo-argentatus		3761
„ aureus		3860
	T.	14000
„ mesomelas		3645
„ lupus		3600
Lycaon tricolor		3801

Hyæna vulgaris	3735
„ crocuta	3820
Herpestes griseus	4662
„ javanicus?	4790
„ fasciatus	4365
„ smithii	4466
„ urinatrix	4236
Viverra civetta	4274
„ tigrina	5365
Felis leo	4322
„ concolor	4465
„ unicolor	4481
„ tigris	4206
„ leopardus	4319
„ jubata	4220
„ pardalis	4616
„ domestica	4404
	T. 16000
Fœtus (½ in. long)	2223
Nucleus	4600
„ bengalensis	4419
„ caracal	4684
„ cervaria	4220
„ serval	4129
Galictis vittata	4175
Mustela zorilla	4270
„ furo	4134
„ vulgaris	4205
„ putorius	4167
Galera barbata	4167
Lutra vulgaris	3502
Trichechus rosmarus	2769
Phoca vitulina	3281
Otaria jubata	3000

Plantigrada.

Meles vulgaris	3940
Arctonyx collaris	3609
Ursus maritimus	3870
„ arctos	3723
„ americanus	3693
„ americanus, var.	3782
„ ferox	3530
„ labiatus	3728
Helarctos malayanus	3562
Mellivora capensis	-3824
Ailurus fulgens	3764
Procyon lotor	3950
Nasua fusca	3789
„ rufa	3878
Bassaris astuta	4033
Cercoleptes caudivolvulus	4573

Insectivora.

Talpa europæa	4747
Erinaceus europæus	4085
Centetes ecaudatus	4085
Sorex tetragonurus	4571
„ indicus	3369

CHEIROPTERA.

Plecotus auritus	4465
Vespertilio murinus	4175
„ noctula	4404
„ pipistrellus	4324
Cynonycteris collaris	3880
Pteropus formosanus	4000
„ poliocephalus	4000
„ medius	4000

QUADRUMANA.

Lemuridæ.

Loris tardigrada	3691
„ gracilis	3461
Lemur albifrons	3976
„ catta	3892
„ anjuanensis	4003
„ nigrifrons	4440

Simiæ platyrrhini.

Midas rosalia	3510
Iacchus vulgaris	3624
Callithrix sciureus	3713
Cebus capucinus	3454
„ apella	3467
Ateles belzebuth	3589
„ ater	3602
„ subpentadactylus	3602

Simiæ catarrhini.

Cynocephalus anubis	3461
„ leucocephalus	3555
Macacus radiatus	3563
„ rhesus	3429
„ niger	3583
„ cynomolgus	3429
„ silenus	3430
„ nemestrinus	3493
„ sylvanus	3338
„ melanotus	3389
Cercopithecus maurus	3468
„ sabæus	3342
	T. 12000
„ fuliginosus	3530
„ ruber	3395
„ pileatus	3578
„ pyrethrus	3401
„ petaurista	3478
„ griseoviridis	3429
„ æthiops	3454
Semnopithecus mona	3515
„ maurus	3515
Hylobates hoolock	3368

Hylobates leucogenys	3425
„ rafflesii	3539
Pithecus satyrus	3383
Simia troglodytes	3412

Bimana.

Homo	3200
	T. 12400
Fœtus (5th month)	3000

EXPLANATIONS OF THE FIGURES ON PLATE LV.

All the objects are red blood-corpuscles done to one and the same scale, which is at the foot of the drawing. The whole length of the scale represents $\frac{1}{400}$ of an English inch, and each one of its ten divisions $\frac{1}{4000}$ of an inch, as described at page 475. Only corpuscles of the average sizes and quite regular shapes are given; and they are all magnified to the same, or nearly the same, degree—to wit, about 800 diameters.

Vertebrata Apyrenæmata.

Homo.

1. Corpuscle lying flat.
2. The same on edge.
3. Membranous base of the same, after removal by water of the colouring-matter.

Quadrumana.

4. Simia troglodytes.
5. Ateles ater.
6. Lemur anguanensis.

Cheiroptera.

7. Cynonycteris collaris.
8. Vespertilio noctula.
9. Vespertilio pipistrellus.

Feræ.

10. Sorex tetragonurus.
11. Ursus labiatus.
12. Bassaris astuta.
13. Cercoleptes caudivolvulus.
14. Trichechus rosmarus.
15. Canis dingo.
16. Mustela zorilla.
17. Felis tigris.
18. Paradoxurus pallasii.
19. Paradoxurus bondar.

Cetacea.

20. Balæna boops.
21. Delphinus globiceps.
22. Delphinus phocæna.

Pachydermata.

23. Elephas indicus.
24. Rhinoceros indicus.
25. Tapirus indicus.
26. Equus caballus.
27. Dicotyles torquatus.
28. Hyrax capensis.

Ruminantia.

29. Tragulus javanicus.
30. Tragulus meminna.
31. Tragulus stanleyanus.
32. Cervus nemorivagus.
33. Capra caucasica.
34. Capra hircus.
35. Bos urus.
36. Camelopardalis giraffa.
37. Auchenia vicugna.
38. Auchenia paco.
39. Auchenia glama.
40. Camelus dromedarius.
41. Camelus bactrianus.
42. Cervus mexicanus (see page 483)

Rodentia.

43. Hydrochœrus capybara.
44. Castor fiber.
45. Sciurus cinereus.
46. Mus messorius.

Edentata.

47. Myrmecophaga jubata.
48. Bradypus didactylus.
49. Dasypus villosus.

Marsupialia.

50. Phascolomys wombat.
51. Hypsiprymnus setosus.

Monotremata.

52. Echidna hystrix.

Vertebrata Pyrenæmata.

Aves.

53. Struthio camelus.
54. The same, made round and deprived of colour by water.
55. Vanga destructor.
56. Lanius excubitor.
57. Bubo virginianus.
58. Syrnea nyctea.
59. Columba rufina.
60. Columba migratoria.
61. Dolichonyx oryzivorus.
62. Buceros rhinoceros.
63. Psittacus augustus.
64. Phasianus superbus.
65. Pelecanus onocrotalus.
66. Trochilus, sp.

Reptilia et Batrachia.
Gymnotus ægyptiacus.
Crocodilus acutus.
Lacerta viridis.
Anguis fragilis.
Coluber berus.
Python tigris.
Bufo vulgaris.
Lissotriton vulgaris.
Sieboldia maxima.
Siren lacertina.
Proteus anguinus.
Amphiuma tridactylum.

Pisces.
Perca cernua, one corpuscle lying flat, the other on edge.
Tinca vulgaris.
Salmo fontinalis.
Esox lucius.
Gymnotus electricus.
Squalus acanthias.
Ammocœtes branchialis.
Lepidosiren annectens.

3. On a Change in the Habits of the *Didunculus strigirostris*. By S. J. Whitmee, C.M.Z.S., F.R.G.S.

[Received May 31, 1875.]

Two or three months ago, in writing to Mr. Sclater on the *Didunculus strigirostris* of the Samoan Islands (P. Z. S. 1874, p. 183), I mentioned that the bird was evidently increasing in numbers, and I thought this increase might be accounted for by a change in its habits in feeding, roosting, and building. I have long known that it feeds now chiefly (I think I may say almost exclusively) upon high trees, instead of upon the ground as it formerly did. But I did not attribute much importance to that fact, because, the bird being wary, I thought its destruction by wild cats to be chiefly in the night when roosting, or when on the nest during the process of incubation, while rats would also destroy the eggs or young in the nest. Hence I did not see how a change in the place of feeding could alone account for the increase of the bird. I therefore made particular inquiries from natives who shoot birds for me as to its roosting. From the information procured on this point I believe the *Didunculi* almost invariably roost now upon the high branches of trees instead of upon low stumps as formerly.

The nest of this bird is so rarely found that few opportunities occur of learning where it builds. In 1871 I procured an egg which was taken from a nest on the ground; but last year I purchased an unfledged bird which was taken from a nest on a tree; and this morning I have received further information on this point which will, I think, be sufficiently interesting to naturalists to be worth sending. I was asking a native to procure some birds for me, and also to look out for eggs, when he said, "I found an egg of the *Manu-mea* (the native name of the *Didunculus*) the other day and threw it away." To this I replied, "What a pity! Why did you not bring it to me? I would have bought it. What was the egg like? and where was the nest?" He answered, "The egg was white like that of the *Lupe* (the *Carpophaga pacifica*); and the nest was in the fork of a tree. I frightened the bird off, but could not shoot it. The *Manu-mea* seems to build on trees now-a-days; I suppose it is on account of the wild cats and rats, is it not? It used to make a nest anywhere on the ground formerly, just like a fowl."

This remark about a change in the place of building the nest was given exactly as I have translated it, without any "leading question" on my part, or any remark which could have suggested it; and I have full confidence in the truthfulness of the native who made it.

From my own observation of living *Didunculi*, I think these birds manifest a considerable amount of intelligence: *e. g.* the young one which I procured last year (which I forwarded to Sydney in December last to be transmitted to the Zoological Society of London) very early recognized persons. I caught it one day to transfer it to a large cage. From that time it took a great dislike to me, which was manifested in the most unmistakable manner whenever I approached it. This intelligence seems to have enabled the bird to change its habits for self-preservation. It has probably been frightened when roosting or during incubation by the attacks of cats, and has sought safety in the trees. Learning, from frequent repetition of the fright, that the ground is a dangerous place, it has acquired the habit of building, roosting, and feeding upon the high trees; and this change of habit is now operating for the preservation of this interesting bird, which was a few years ago almost extinct.

Samoa, March 13th, 1874.

4. On the Habits of *Palola viridis*.

By S. J. Whitmee, C.M.Z.S., F.R.G.S.

[Received May 31, 1875.]

From the article "Helminthology" in the 'Encyclopædia Britannica'*, I see a notice of this annelid is in the 'Proceedings' of the Society for March 9th, 1847. A paper on it has also appeared in vol. xxii. of the Linnean Society's 'Transactions' by Dr. Macdonald. I have not seen either of these papers; but I presume the worm is fully described in them. Very good magnified figures of the head and the posterior extremity of the *Palola* are copied from Dr. Macdonald's paper in the late Dr. Seemann's 'Mission to Viti'†. I shall confine the present paper to an account of the time of the *Palolo's* appearance during several years, and some observations on its habits which I made in 1872 and 1873.

The Palolo‡ appears regularly at the time of the moon's last quarter in October and November. I am indebted to the Rev. George Brown, of the Wesleyan Missionary Society (who resided several years at a place on the island of Savaii, where it is very abundant) for the following dates of the worm's appearance:—

1862. Oct. 15th. A small number only.
,, Oct. 16th (day of moon's quartering). *Palolo* plentiful.

* Enc. Brit. xi. 297. † Mission to Viti, p. 62.

‡ I employ this form in both the singular and plural number, according to Polynesian usage.

1862. Nov. 14th (day of moon's quartering). Plentiful.
„ Nov. 15th. Plentiful.
No observations were made in 1863.
1864. Oct. 22nd. None.
„ Oct. 23rd (day of moon's quartering). Palolo obtained, but quantity unknown.
„ Oct. 24th. None.
„ Nov. 21st. Very few obtained.
„ Nov. 22nd. None.
1865. Oct. 12th (day of moon's quartering). Abundant.
„ Oct. 13th. Plentiful.
No observations made in November.
1866. Oct. 31st (day of moon's quartering). A few appeared.
„ Nov. 1st. Plentiful.
No other observation made this year.
1867. Oct. 21st (day of moon's quartering). Very abundant.
„ Oct. 22nd. None appeared.
1868. Oct. 8th. Plentiful.
„ Oct. 9th (day of moon's quartering). Plentiful.
„ Nov. 8th (day of moon's quartering). Abundant.
„ Nov. 9th. None appeared.

The Palolo is not found at any place within several miles of my residence; and I had no opportunity of visiting a place where it appears until 1872. The moon quartered that year on the 24th October; and on that day the Palolo were expected; but I was at the place on the evening of the 22nd. Two hours before sunrise on October 23rd I went with some natives in a canoe to a part of the reef where they are usually found; but we only obtained a single specimen. During the day I had some blocks of both living and dead coral taken on shore from a spot where the natives said Palolo appeared. These I carefully broke up to search for the worm. As I was breaking one block of dead coral I found a single living Palolo in one of its interstices. This was the only one I found, although I broke several blocks. Before daylight on the morning of the 24th I went out again. About a hundred canoes with natives were already on the spot, and the Palolo were beginning to appear. Putting my hand into the water as my canoe was paddled along, every now and again one of the little creatures passed between my fingers or twined itself about them. Half an hour after reaching the place, they had become so abundant that I could take them up by the handful.

The first point to which I gave my attention was the places where they appeared. I found them thickest in certain spots just on the edge of the reef, and especially in an opening where there was a depth of water of about two fathoms. They were scattered over a considerable surface of the smooth water inside the reef, but only in small quantities, and the number decreased the further I went from the edge of the reef. Over the spot whence I had taken coral blocks for examination on the previous day they were very sparsely distributed.

The next thing I observed was their mode of progression through the water. They move rapidly, and with considerable elegance, in a spiral manner, like a screw. The shortest, which were about 6 inches long, had generally two coils, while the longest, which were fully 18 inches long, had as many as five or six coils. The best representation of their appearance I think of is the tendril of a climbing plant, with a coil to about each three inches of its length. In places where the Palolo were plentiful they seemed to be entangled in an inextricable mass.

The worms were of two colours, green and light brown *. Taking a green one into the palm of my hand with a little water, I subjected it to slight pressure with my finger, when it broke into pieces of from half an inch to an inch and a half in length, and each piece wriggled about until it subdivided once or twice. From each fracture there immediately flowed out an innumerable quantity of minute green eggs, until nothing was left of the pieces into which the worm had broken except thin transparent cysts. Next, taking one of the light-brown worms into my hand, it ruptured exactly as the green one did, and from each end of the pieces a whitish fluid freely flowed, leaving, as in the green worm, only thin transparent cysts. It was evident these were the two sexes, and that, while the females were filled with ova (a small portion of each extremity excepted), the males were as completely filled with the seminal vesicles.

The question now was, how are the ova of the female fertilized? I saw no sexual contact. But the secret of the appearance of the Palolo seemed solved : by this time the sun had been half an hour above the horizon ; and the worms were rapidly breaking to pieces in the sea just as those had broken which I took into my hand. Where they were thickest the sea was discoloured with the milky seminal fluid which was escaping from both ends of each piece of the brown male worms ; and by taking a small quantity of sea-water into the palm of my hand, I found it to be full of the minute green eggs which had flowed from the ruptures of the green female Palolo. Hence this breaking-up appeared to be a natural process by which the species is propagated, the eggs being fertilized by contact with the semen while floating in the sea.

I felt fully convinced this was the mode of propagation of the Palolo, and that this fully accounted for its regular appearance, but resolved to wait and make another observation before communicating my opinion to the Society. I therefore visited the same place on the 11th November, 1873, hoping to have another opportunity of seeing

* In the late Dr. Seemann's 'Mission to Viti,' p. 61, it is said, "They are of various colours, green, red, brown, and sometimes white." Although I have had Palolo brought to me by the natives for several years, I have never seen more than two colours ; but some of the brown ones are of a lighter shade than others. I have occasionally found specimens of another annelid, which was red, mixed with a mass of Palolo. When preserved in alcohol or Goatby's solution, the brown worms get stained with the colour of the green ones. Hence the origin of the specific name. As will appear further on, the green colour is confined to the eggs of the gravid female. Hence, except when they are full of eggs, and the brown ones are stained by the green colouring-matter, this name is inappropriate.

the Palolo on the morning of the 12th, when the moon quartered. In this I was not disappointed. They were more abundant this year than they had been the previous one. I confined my attention almost entirely to the contact of the worms with each other, and to their breaking into pieces. Early in the morning I caught three green and three brown ones, and placed them in a large glass vessel which I had provided for the purpose. While observing the worms which were swimming freely in the sea, I also kept my eye upon my captives. I saw no sexual contact either between those in the vessel or those in the sea. They all went gyrating about until a little after sunrise. Then I observed those in the vessel begin to break, first into long pieces, each example separating into two or three parts, while these pieces continued to subdivide into minute portions. I observed those in the sea divided in the same manner and at the same time. This continued till about 8 o'clock A.M., by which time those in the sea had nearly disappeared. The six worms in the vessel were also completely broken up, the water (about half a gallon) being rendered somewhat turbid, as if a dessert-spoonful of milk had been mixed with it. The green ova were floating in all parts of the water, but were gently settling towards the bottom. The empty cysts of the defunct worms were lying on the bottom of the vessel. I brought them home with me, and emptied the whole into a small aquarium, which I am leaving undisturbed to see if the eggs will develop there*. By the time I reached home, about 1 P.M., all the ova had settled to the bottom of the vessel, notwithstanding the constant agitation of the water by the motion of the boat in which I brought it.

I wish specially to direct attention to the following interesting fact respecting the appearance of the Palolo. Although it comes only at one particular state of the moon (the time of the last quarter), it still keeps solar time in the long run. As far as I have certain information, it has only been seen in October, November, and occasionally, but very rarely, in December. Now it is evident that if the intervals between its appearance were regularly 12 lunations, the months during which it is found would be constantly changing, since it would appear about 11 days earlier each year. If, on the other hand, the intervals were regularly 13 lunations, it would come about 18 days later every year, and the months of its appearance would change still more rapidly.

Having only lately given any attention to this matter, it was with considerable surprise I discovered, from the dates of its appearance, that in each period of three years there are two intervals of 12 lunations each, while in one interval there are 13 lunations. Unfortunately the observations given in the early part of this paper were not all consecutive, so that I cannot say positively that the length of the intervals proceeds in regular order, two years of 12 lunations being invariably followed by one of 13 lunations; but the rule holds good in the aggregate of 12 years over which the observations extend, there being 8 years of 12 lunations each, and 4 years of 13 lunations each. This will appear from the following table, in

* P.S. They did not develop in the aquarium.—March 17, 1875.

which I include the notice of the appearance of Palolo in Fiji in November 1861, given in Dr. Seemann's work already mentioned.

From Nov. 25th,	1861, to	Nov. 14th,	1862, 12	lunations.
" Oct. 16th, / " Nov. 14th,	1862, to	Oct. 23rd, / Nov. 21st,	1864, 25	"
" Oct. 23rd,	1864, to	Oct. 12th,	1865, 12	"
" Oct. 12th,	1865, to	Oct. 31st,	1866, 13	"
" Oct. 31st,	1866, to	Oct. 21st,	1867, 12	"
" Oct. 21st,	1867, to	Oct. 9th,	1868, 12	"
" Oct. 9th,	1868, to	Oct. 24th,	1872, 50	"
" Oct. 24th, / " Nov. 22nd,	1872, to	Oct. 12th, / Nov. 11th,	1873, 12	"

From the above table it appears that either in 1862–1863 or 1863–1864 there were 13 lunations; I believe it was in 1862–1863, for the following reason. If there were only 12 lunations that year, then the Palolo appeared on the 4th of October, 1863, a date earlier than any I have heard of. In the interval between Mr. Brown's observation on Oct. 9th, 1868, and my first observation on Oct. 24th, 1872, there were 50 lunations—2 seasons of 12 lunations each, and 2 of 13 each. I believe the long periods of 13 lunations occurred in 1868–1869 and 1871–1872; for if there were only 12 lunations in these years, then the Palolo appeared on the 28th and 24th of September respectively; and these dates are, according to all our information, too early for the appearance of the worm. Hence I believe the periods of 13 lunations to have been regularly every third year, as follows:—1862–1863, 1865–1866, 1868–1869, and 1871–1872.

But the regular addition of one lunation every third year would still lead to a change in the months of the Palolo's appearance. The 37 lunations of a three years-cycle are rather more than 3 days less than 3 solar years *. Hence to keep the season from changing from October and November to September and October, &c., an extra lunation would need to be intercalated about every 30 years or rather less †. If this were not done, the season would still change more than

* The above is a rough estimate; the following is the exact time:—

	d.	h.	m.	s.
Three mean solar years =	1095	18	27	27
Thirty-seven lunations =	1092	15	19	14
Excess of 3 solar years above 37 lunations ...	3	3	8	13

† The intercalation of 2 lunations in 57 years would be required, making a large cycle of two unequal periods, viz. one of 28 and the other of 29 years. This will be seen by the following:—

	d.	h.	m.	s.
The excess of $3^d\ 3^h\ 8^m\ 13^s$ every third year would amount in 57 years to	59	11	35	7
Two intercalated lunations (one 28 years and and one 29) =	59	1	28	4
Leaving an excess in 57 years of only	0	9	7	3

This is less than one day in an entire century.

[These notes I add March 17th, 1875.—S. J. W.]

three months (from October and November to July and August) in a single century. That such a change has not taken place I believe is certain. It is now twenty-seven or twenty-eight years since the Palolo season was carefully observed by the missionaries then resident in Samoa, and their observations recorded in Europe *. That no change has taken place since then the dates given in this paper prove.

I think it probable that there will be an extra intercalation of one lunation during the present year. If I am correct in my theory of 13 lunations every third year, and that the last period of 13 lunations was 1871–1872, the present interval ought (according to the smaller cycle) to be one of 12 lunations. This would bring the time of the worm's appearance to October 2nd of the present year (1874). But, as I have already stated, that date would be earlier in the month than any appearance of which we have certain knowledge. Hence I am inclined to predict the next appearance of *Palolo* on the 31st of October (local time), after an interval of 13 lunations from the corresponding October season in 1873 †.

In Dr. Seemann's work it is said the Fijians "expect a heavy shower of rain" after the Palolo have been cooked, "to put out the fires of their ovens. Should there be no rain a bad yam season is predicted." The Samoans have no such superstition as that of the Fijians connected with the Palolo; but they have from time immemorial recognized the fact that this worm makes its appearance at the time when a change of seasons takes place. Hence the time when the prevailing trade-wind changes from S.E. to N.E. at the commencement of the summer, or rainy season, is called the *vāi-palolo,* which means the space or time of the Palolo. The opposite season, when the trade-wind changes from N.E. to S.E. at the commencement of the dry season, is in like manner called the *vāi-to'elau,* meaning the space or time of the change from the north wind. This is, in my opinion, very positively in favour of the absolute identity, as to the time of year, of the present with the past Palolo seasons for a very long period. The *vāi-palolo* is as much an integral part of the Samoan dialect as is our word *spring* (with which it corresponds) an integral part of the English language; and its origin is not modern.

From the foregoing it is evident that a most remarkable compensation for the difference between *lunar* and *solar* time is made by some natural process in the development of this little annelid. I am not at present prepared to give an opinion as to how this can be effected.

N.B. Since writing the preceding, I have explained to an intelligent Samoan the occurrence of 13 lunations between the appearance of the Palolo every third year. After thinking a minute or two, he said, "That is the reason why so many mistakes have been made by Samoans in predicting the moon during which the Palolo will appear.

* *Vide* Enc. Brit. xi. p. 297, and P. Z. S. March 9th, 1847.

† This has since proved to be correct. See P.S. of March 17th, 1875.

We usually know the *day*, but often are in error as to the moon, and expect it one too early." In their old mode of reckoning the Samoans knew when the season was approaching by the flowering of certain plants. They found the *day* by the position of the moon. The *tenth* morning on which the moon is seen above the western horizon at dawn of day is the morning on which the Palolo appear. The Samoans always call the Palolo a fish (*i'a*=*ika* in other Polynesian dialects, and *ikau* in Malayan). This is the origin of a mistake made by one of the former missionaries, mentioned in the 'Encyclopædia Britannica.'

Upolu, Samoa, March 20th, 1874.

P.S. March 17th, 1875.

The preceding paper was forwarded to the Zoological Society of London by the mail *viâ* San Francisco in March, 1874; but having heard from Mr. Sclater that it had not reached him on October 30th last, I now forward another copy, to which I have added a few notes under the present date.

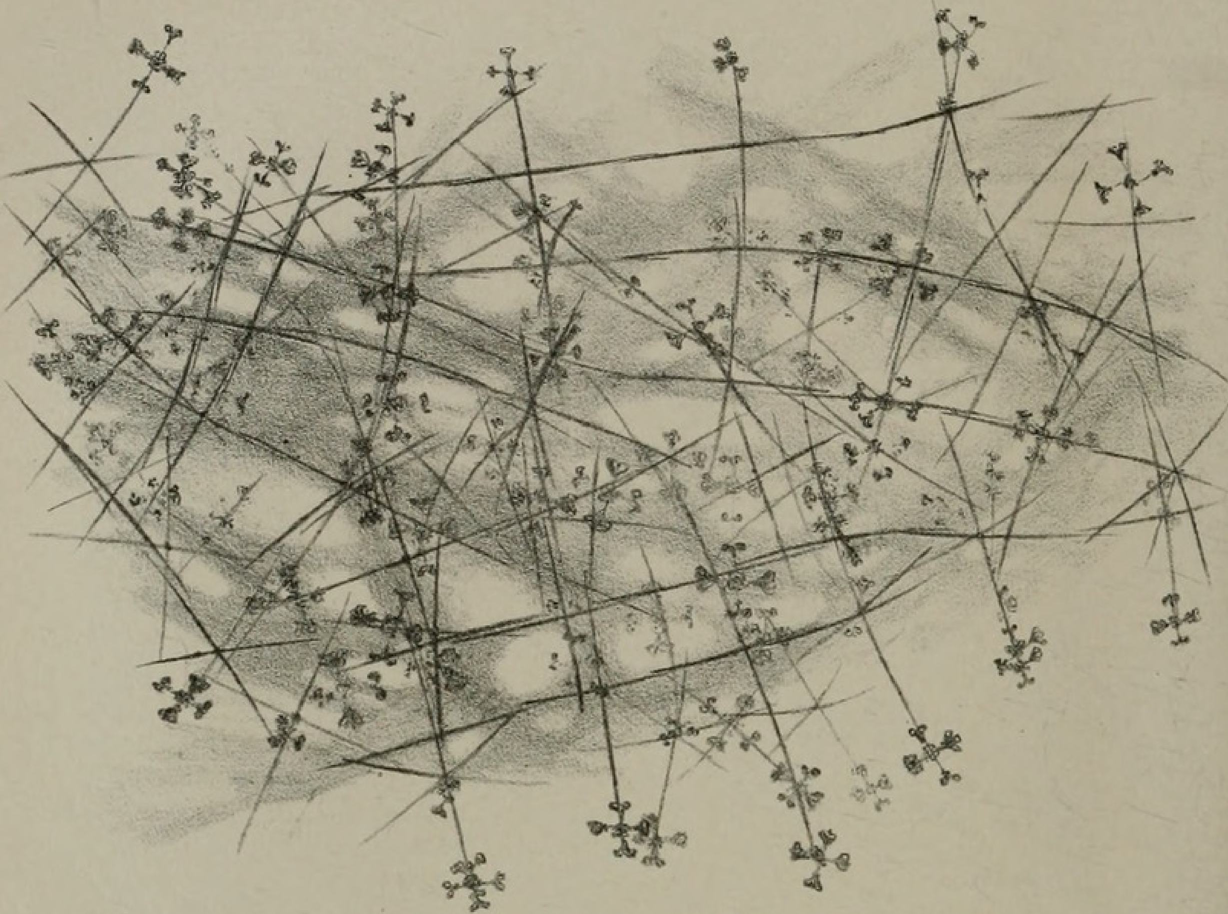
In a note dated Nov. 17th, 1874, I have already informed Mr. Sclater that the Palolo appeared in these islands on October 31st and November 1st, G. M. T.,=November 1st and 2nd local time, thus proving the correctness of my opinion that that season would be one of 13 lunations.

I sent a copy of the foregoing paper to Mr. E. L. Layard, F.Z S., now Administrator of the Government in the colony of Fiji, in order that he might check my observations in those islands. I am sure he will excuse me for giving the following interesting quotation from his letter, dated Levuka, Dec. 9th, 1874, communicating his own observations:—

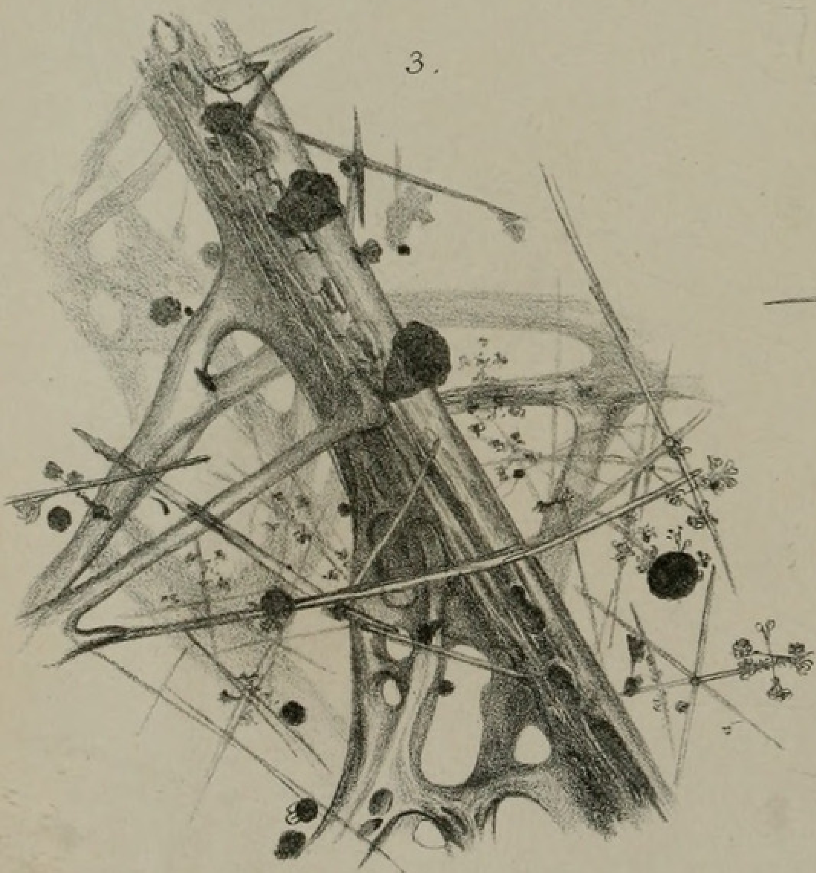
"I studied your paper with much interest, and anxiously awaited the time of the worm's appearance. The date assigned by you was very rough and stormy. The natives here laughed at the date—'Oh, it will be later!' Time came; no balolo! I was out, one among thirty boats. 'Oh, we have missed it by three days; it will be later.' Meanwhile news came from Loma-loma that they had them on *the very day you name*, the biggest take of balolo ever known. I now have my laugh at the people."

Mr. Layard obtained half a dozen specimens, and he says, "All took place as you observed. With my high-power glasses I found the eggs to be spotted; and I fancy the spots were the orifices by which the seminal vesicles of the male enter. These are very active in the water, gyrating in a singular manner. One male 1 inch long was enough to dim the transparency of 8 oz. of water. I saw no worm longer than $1\frac{1}{2}$ inch, but received one 18 inches long from Loma-loma."

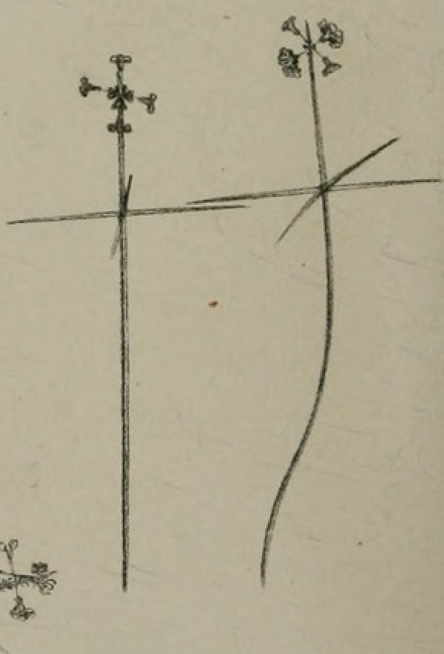
1.



3.



2.

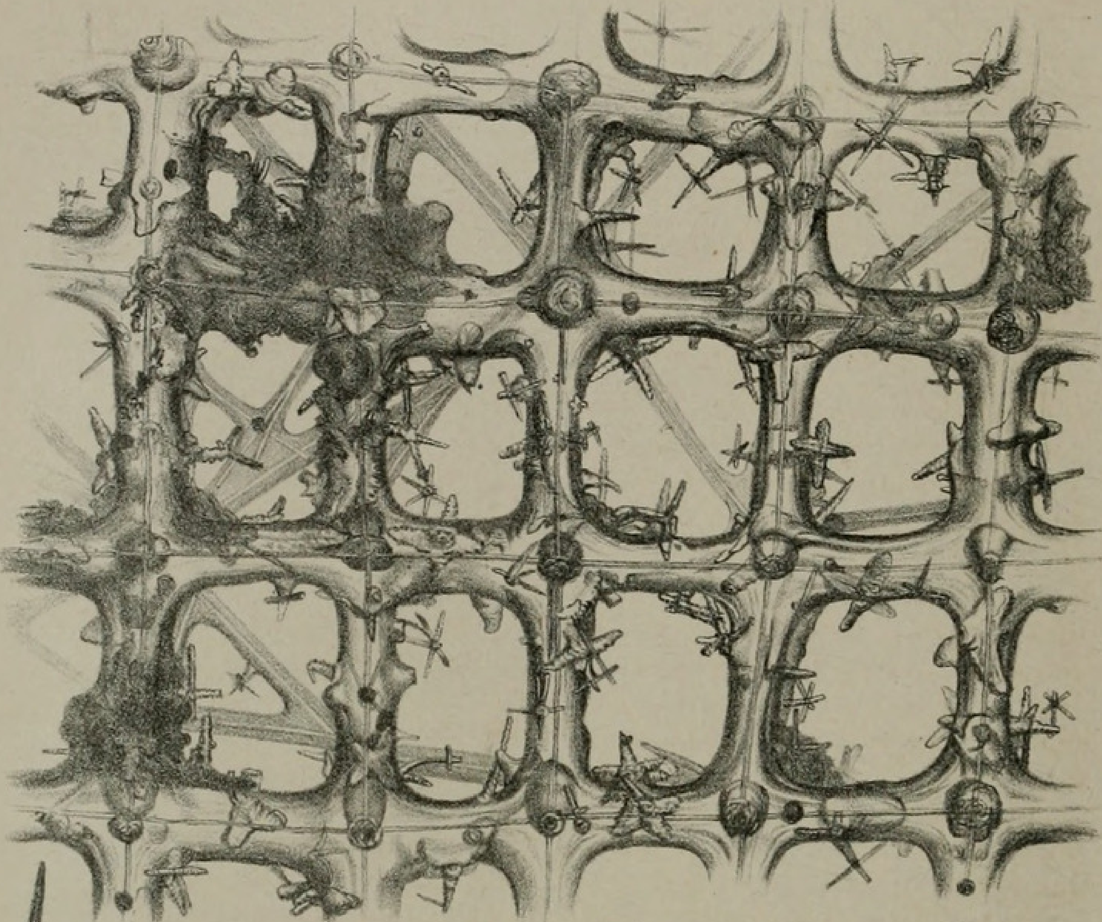


Alcyoncellum speciosum.

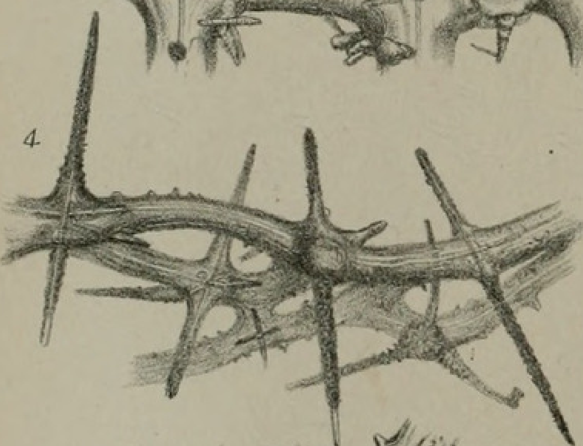
J. Dinkel del. et lith.

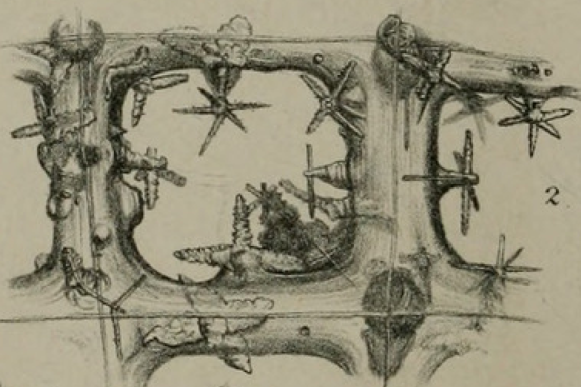
W. West & C° imp.

1.



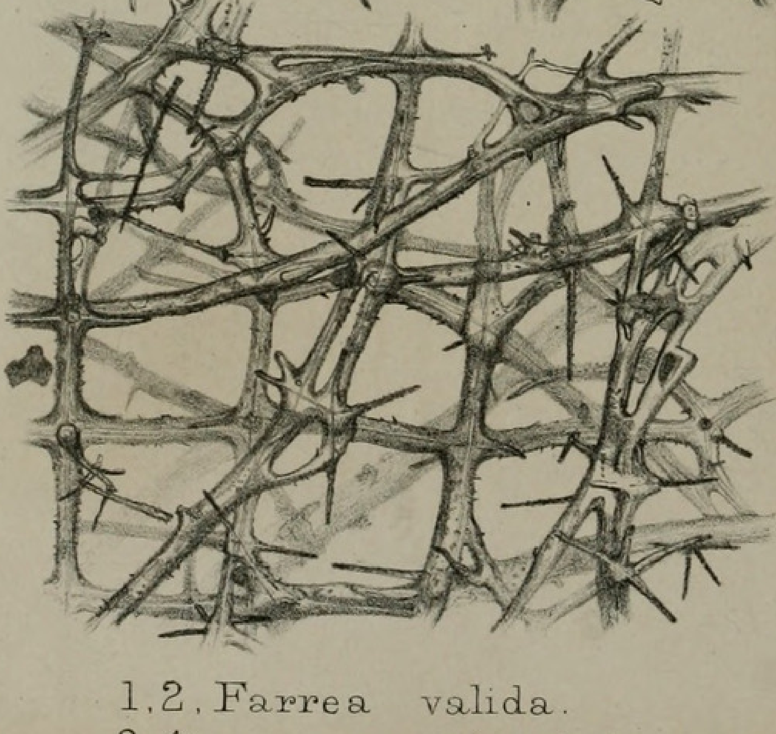
4





2.

3.



1, 2, Farrea valida.
3, 4, „ spinosissima.

J. Dinkel del. et lith.

W. West & C° imp.

5. A Monograph of the Siliceo-fibrous Sponges. By J. S. Bowerbank, LL.D., F.R.S., F.Z.S., &c.—Part IV.

[Received June 8, 1875.]

(Plates LVI. & LVII.)

Further observations on the anatomy and physiology of

Alcyoncellum speciosum, Quoy et Gaimard. (Plate LVI.)

Euplectella aspergillum, Owen, Trans. Zool. Soc. iii. p. 203.

Euplectella cucumer, Owen, Trans. Linn. Soc. xxii. p. 17, pl. 21.

In my former observations on the anatomy and physiology of this singular and very beautiful Sponge, published in the Society's 'Proceedings' for 1867, p. 351, and for 1869, p. 346, I have stated that I had tried in vain to obtain a knowledge of the dermal structures of this sponge. In my paper of May 13, 1869, I detailed my examination of a very small fragment of what appeared to me to be the dermis; and subsequent examinations of other minute pieces of a similar description have confirmed the opinion I had then formed. Since 1869 I have made every possible effort to solve the problem of its dermal structure, but without any satisfactory result. What my best efforts could not attain, the good fortune of my friend Dr. John Miller, F.G.S. &c., has achieved by the acquisition of a specimen in which the skeleton of the dermal organization is in a perfect state of preservation; and I am much indebted to him for having kindly presented me with part of this beautiful and valuable specimen for examination and description. No portion of the sarcodous structures remain on any part of the specimen. These tissues appear to have been removed from the dermis by gradual undisturbed decomposition, leaving its siliceous skeleton *in situ* in a remarkably perfect state of preservation; and not only so with regard to the dermal skeleton, but the rigid skeleton of the sponge appears to be precisely in the same state as when living, every portion of it appearing to occupy its appropriate position, so as to enable us to render a much more correct account of its general structure. Hitherto the only specimens available for examination have been in such a well-washed condition as to render it extremely difficult to determine the true positions of the unattached spicula found among those of the rigid skeleton; and in many cases the rectangulated sexradiate spicula of the dermis and the floricomo-sexradiate ones have evidently been washed into the interstices of the rigid skeleton.

On examining a portion of the sponge presented to me by Dr. Miller, mounted in Canada balsam, with a power of 100 linear, we find that at the inner surface of the specimen the large primary fibres of the skeleton are strikingly distinct; and in the irregularly shaped interstices of their reticulation there were numerous stout rectangulated sexradiate spicula, and a large number of the same form of various degrees of tenuity; their positions were mostly unconformable, both as regards each other and the large primary fibres of the skeleton; and I could not detect a single floricomo-sexradiate one among them. The simple rectangulated sexradiate spicula, when immersed amid the skeleton-fibres, usually had the whole of the six radii developed; but those at the inner margin of the great incurrent areas were frequently deficient of the distal axial ray, so that the four lateral rays were presented in the same plane as that of the inner margin of the great incurrent areas.

On examining the outer surface of the specimen we find a marvellously beautiful compound reticulated dermal skeleton elevated slightly above the general surface of the sponge-structures beneath. This exquisitely beautiful tissue is composed of a single layer of slender, simple, rectangulated sexradiate spicula, conformably arranged in the same plane, the long proximal ends of the central shafts being all pointed downwards towards the skeleton beneath, while the lateral radii of each spiculum glide over those of their next neighbours until the distal ends of their respective rays closely approach to the central shafts of each other, thus systematically interlocking with each other, and forming a beautiful quadrangular network in the dermal stratum. The distal portion of the central shaft of each simple rectangulated sexradiate spiculum has a single floricomo-sexradiate spiculum cemented to its apex, forming a uniform stratum at regular distances of these beautiful objects immediately beneath the outer surface of the dermal membrane.

The interstices of the quadrangular network are filled by a thin translucent membrane on which there are occasionally found, closely adhering to the membrane, groups of five or six minute quadrifurcate sexradiate stellate spicula, very similar in general structure to those of *Iphiteon Ingalli*, figured in the Society's 'Proceedings' for 1869, plate xxiii. fig. 2, p. 331—but with this difference, that the radii of those of *I. Ingalli* are spinulate, while those of *A. speciosum* are attenuated to exceedingly sharp distal terminations. These spicula are very slender and delicate in their proportions, and require a power of at least 400 linear to render them distinctly to the eye. A fully developed one measured as follows:—extreme diameter $\frac{1}{428}$ inch; diameter of the sexradiate basal portion $\frac{1}{1500}$ inch; length of the furcating radii $\frac{1}{1000}$ inch; and the diameter of the thickest portion of furcating radii $\frac{1}{13000}$ inch.

Thus these beautifully constructed and elaborately arranged organs form most effective defences against minute annelids or other insidious enemies who may attempt to prey upon the soft gelatinous tissues of the sponge. A single mouthful of the minute sharp-pointed spicula of which their beautiful floral terminations are constructed would effectually deter these predacious little enemies from any further attacks upon the soft tissues of the sponge. A more complete or more effective mode of disposition of these wonderful defensive organs cannot possibly be conceived. These structures are amazingly beautiful to our eyes; but their admirable adaptation to their especial purposes infinitely surpasses their beauty in our estimation. To return to the peculiar mode of construction of the rectangulated network of the dermis, we at once perceive that the spicula when thus united form a strong and elastic rectangulated network. This mode of combination of the simple sexradiate spicula is perfectly adapted to the power of dilatation and contraction that it appears should necessarily exist in all siliceous sponges, whatever their form may be, which have a rigid skeleton. We find these powers existing in all the species of *Dactylocalyx*, as represented in plates v. & vi., P. Z. S. 1869. But in these cases the expansion of the dermis is effected by various forms of ternate spicula, connected by the apices of their terminal radii, while their shafts are directed towards the body of the sponge, so as to allow, not only of a great amount of lateral expansion and contraction of the dermal membrane, but also of the separation of the dermis from the body of the sponge beneath it to a very considerable extent. In all the species of *Geodia* and *Pachymatisma* we find the same principle existing under various modifications. The expansile powers of the dermal tissues are also provided for, in the reticulated structures of *Isodictya* and *Halichondria*, by the conjunction and elastic adhesion of the terminations of the spicula forming the dermal rete, whether that organ be monospiculous, as in many species of *Isodictya*, or multispiculous, as in numerous species of *Halichondria* and several other genera; and where no such structures exist the dermal membrane alone is abundantly elastic, as exhibited in the protrusion of the large excurrent orifices in *Spongilla*, as figured in plate i. in the "Report on the Vital Powers of the Spongiadæ," in the Reports of the British Association for 1857. All these beautiful appliances appear to be combined in the structure of the dermis of *Alcyoncellum*; and in addition we have the floricomo-sexradiate forms terminating the distal apices of the dermal expansible arrangement of spicula, as defences of the external surface of the dermal membrane against the minute enemies, while the *chevaux-de-frise* forms beneath are an ample and effective defence against the more powerful depredators.

The spicula of the expansile dermal tissues vary in structure to a considerable extent in the different species of sponges in which they occur. In *Geodia Dysoni* they assume the form of simple patento-ternate spicula, their distal terminations being all in the same plane, their radii meeting and overlapping each other more or less, as represented in figs. 4 & 5, plate iii., P. Z. S. 1873; or they occur as bifurcated patento-ternate ones, as represented in figures 3 & 4, plate ii., P. Z. S. 1873, in the dermis of *Geodia perarmatus*. In the similar organs of *Dactylocalyx Pratti* their terminal radii are flattened and contorted to a considerable extent, as shown by figs. 9, 10, 11, plate v., P. Z. S. 1869; and in the same plate the radii of these spicula are expanded into beautiful foliations in the dermis of *Dactylocalyx M'Andrewii*, as represented in figures 2, 3, & 4. But however different their forms may be, their office in the expansile dermis of each sponge is precisely the same, and their long basal shafts are pendent, as represented in the section at right angles to the surface of *Dactylocalyx Prattii* in plate v. fig. 6*a*, P. Z. S. 1869. In all these cases the same design, with variations adapted to the particular species, is apparent—that of allowing a considerable amount of expansion and contraction in the dermal system of the animal, so that, if the skeletons are rigid, the necessary expansions of the dermal organs of the animal may achieve inhalation and exhalation, as necessary to the sponge as to the higher classes of animals, of marine or land-living creatures; and this is precisely what takes place in the dermal system of *Alcyoncellum speciosum*, but in a more complicated and beautiful manner than in any other siliceo-fibrous sponge with which I am acquainted.

There are several other varieties of form of the remarkably constricted compound floricomous spicula which are figured in the 'Philosophical Transactions of the Royal Society' for 1857, plate xxvii., and also in plate viii. vol. i. 'Monograph of British Spongiadæ;' but none of these forms are elevated on the distal portion of the shaft of a simple rectangulated sexradiate spiculum, as in *Alcyoncellum speciosum*.

In the portion of the specimen mounted in Canada balsam in the cabinet of Dr. Miller I found a considerable number of gemmules dispersed amidst the tissues; some were on the skeleton-fibres, while others were attached to the interstitial membranes. They were membranous and aspiculous, closely resembling the same description of organs in *Dactylocalyx pumicea*, as represented in the 'Philosophical Transactions of the Royal Society' for 1862, plate xxxiv. figs. 17 & 18, and also in 'Monograph of British Spongidæ,' vol. i. plate xxv. figs. 340 & 341. They varied in size to a much greater extent than those of *Dactylocalyx*. The largest one measured $\frac{1}{389}$ inch in diameter; another was $\frac{1}{800}$ inch in diameter; and the specimens ranging between these two sizes were comparatively numerous. Others, equally well developed, measured $\frac{1}{2000}$ inch; and the smallest well-defined one was but $\frac{1}{2666}$ inch in diameter.

Thus we have, by the aid of Dr. Miller's beautiful specimen, obtained a much more correct knowledge of the anatomy and physiology of this beautiful sponge than we previously possessed; and, in addition to these interesting facts, a letter published in the 'Times' April 30, 1875, from Her Majesty's ship 'Challenger,' contains some interesting information regarding its habits in its natural state. "The regaderas," as the Spaniards call them, "are found at a depth of about 100 fathoms. The Indian lets down his bamboo arrangement with a strong fine line of Manilla hemp, and pulls it slowly over the ground. Every now and then he feels a slight tug; and at the end of an hour or so he pulls it in, with usually from five to ten 'regaderas' entangled on the hooks. *Euplectella* has a very different appearance, under these circumstances, from the cones of glossy network in the British Museum. Its silver beard is clogged with the dark grey mud in which it lives, buried to about one third of its height; and the network of the remainder of the tube is covered with a pall of yellowish fleshy matter, which gives it a heavy look, and greatly diminishes its beauty. The layer of flesh is not so thick as we expected, and only slightly masks the form of even the detailed sculpture of the sponge."

In my description of *A. speciosum*, in P. Z. S., May 13, 1869, p. 346, I described a small fragment of what was probably the dermal membrane of the sponge, beneath which the elaborate and beautiful defensive arrangement of spicula described in this paper would be situated. The account of this little fragment foreshadows the description of the investing animal tissues of the sponge described by the correspondent from the 'Challenger,' quoted above.

Farrea valida, Bowerbank. (Plate LVII. figs. 1 & 2.)

Sponge-mass unknown. Dermis furnished with a stout, quadrilateral, smooth or, rarely, slightly tuberculated siliceo-fibrous network, armed at the angles externally and internally with short, stout, imbricated, conical spicular defences; areas square or slightly oblong, very regular, sides of the areas abundantly armed with rectangulated sexradiate defensive organs; radii spinous; spines acutely conical; fibres of the dermal rete cylindrical, very stout, equable in size, canaliculated; canals regular, strongly produced, confluent at the angles. Skeleton-rete quadrangular, areas larger than those of the dermal network. Fibre smooth, not more than one third the diameter of those of the dermis; canals large and well developed. Dermal membrane obsolete.

Colour, in the dried state, dark amber-brown.
Hab. Unknown.
Examined in the dried state.

All that I know of this sponge is a piece of the dermal network a quarter of an inch in length by one eighth of an inch in breadth. It is mounted in Canada balsam. Beneath the dermal rete there is a small portion of the true skeleton-rete *in situ*.

The specific characters derivable from the dermal structures are remarkably striking. The fibres of the dermal structure are comparatively very large; their average diameter measured $\frac{1}{250}$ inch, while those of the true skeleton averaged $\frac{1}{750}$ inch only, and the central canals in both measured $\frac{1}{3000}$ inch. The fibres of the dermal structure are spineless; but there are occasionally a few low rounded tubercles dispersed on their surfaces. The mode of the reticulation is exceedingly regular; and the areas are all square or, to a slight extent, oblong, slightly curved at the angles. The conical spicular defensive organs at the angles are short, but very stout, and the imbricated scales are strongly produced. The most strikingly distinctive characters are the numerous rectangulated sexradiate defensive organs, based on the dermal fibres, and projected into the areas frequently to the extent of half their breadth. Their number is very considerable; and four or five are not uncommon in a single area. They vary in size and form to a very considerable extent, some being exceedingly stout, and abundantly and strongly spinous, while others are slender and delicately spinous. All these organs appear to be furnished with a central canal; but it is frequently rendered indistinct by the profusion of spines on the surface of the organ. The small portion of the true skeleton does not present any remarkable characters. The fibres are usually quite smooth; occasionally, however, there are small and very immature rectangulated sexradiate defensive organs; but I did not see a single well-produced one. There were a few small portions of the dermal membrane in a good state of preservation, upon which there was a rather thick layer of sarcode; but I could not detect in it any thing in the shape of spicula. The specimen from which the above description has been made was in the possession of my late friend Mr. Henry Deane, who kindly obliged me with the use of it for description; and his son, Mr. James Deane, has kindly given me the specimen.

Farrea spinosissima, Bowerbank. (Plate LVII. figs. 3 & 4.)

Sponge cup-shaped? Dermis, oscula, and pores unknown. Skeleton rectangulated, composed of three or four layers; fibres of the external ones of rather greater diameter than those intervening, more regularly disposed; areas variable in size and form, abundantly armed with very long, slender, defensive prickles, projected in various directions, more or less incipiently spinous, spines acutely conical—and also sparingly with rather small rectangulated sexradiate internal defensive organs. Skeleton-fibre rather slender, usually smooth, occasionally furnished with a few acutely conical spines; central canals variable in size, usually slender, occasionally obsolete. Sarcode, in the dried state, dark amber-brown.

Colour, in the dried state, dark amber-brown.
Hab. Unknown.
Examined in the skeleton-state.

I am indebted to my late friend Mr. Henry Deane for the only specimen of this species with which I am acquainted. It is a plate of skeleton-tissue 8 lines in diameter. It is curved to such an extent as would seem to indicate that it had formed part of a cup-shaped sponge two or three inches in diameter. In some parts of the structure there are as many as four layers of the skeleton-tissue; but the number most frequently seen is three. The prominent and most distinctive character is the long slender prickles projecting from the skeleton-fibres at right angles to their long axis; sometimes one only is thus produced, but more frequently two in opposite directions, or three are thus projected at about equal distances from a line encircling a fibre. They are always very slender; but they differ in length to a considerable extent: in some cases their length is about equal to the diameter of the fibre on which they are based; but they are frequently three or four times that length. I could not detect the slightest indication of dermal or interstitial membranes with a power of 80 linear; nearly the whole of the skeleton-fibres were more or less covered by a thin coat of dark amber-coloured sarcode; and the long defensive prickles were much more thickly coated with the sarcode than the skeleton-fibres; and this coating of the prickles was mostly thin at their proximal ends, and gradually increased in its thickness to their distal extremities, frequently becoming slightly clavate.

A few such prickles as described above occur in *F. spinifera*; but the greater size of the skeleton-fibres and their more compact and regular mode of arrangement, their large and very distinct canals, at once distinguish that species from *F. spinosissima*.

DESCRIPTION OF THE PLATES.

Plate LVI.

Fig. 1 represents a portion of the skeleton of the dermal system of *Alcyoncellum speciosum*, as seen *in situ* on a piece of Dr. Miller's specimen of the sponge mounted by him in Canada balsam, exhibiting the mode of arrangement of the slender rectangulated sexradiate spicula, with the floricomo-sexradiate defensive ones attached to the distal terminations of each of the reticulating spicula, × 36 linear. In plate xxiv. P. Z. S. for 1869, fig. 11 represents one of the floricomo-sexradiate spicula × 666 linear; fig. 10 one of the dermal simple rectangulated sexradiate spicula to which the floricomo-sexradiate ones are attached, × 108 linear; and fig. 9 represents one of the slender attenuated rectangular sexradiate spicula of the skeleton interstitial structures, × 175 linear.

Fig. 2. Two of the slender rectangulated sexradiate dermal spicula as seen *in situ*, showing the mode in which the lateral radii pass freely over each other, so as to allow of the expansile action of the dermal system, ×80 linear.

Fig. 3. A small piece of the skeleton-fibres of the sponge immediately beneath the dermal system, with numerous gemmules in various stages of development, attached either to the fibres of the skeleton or to the translucent interstitial membranes, × 80 linear.

Plate LVII.

Fig. 1 represents a small portion of the stout and beautifully regular dermal reticulation of *Farrea valida*, with its numerous rectangulated sexradiate defensive organs based on the fibres, with a portion of the slender reticulated skeleton beneath it, × 61 linear.

Fig. 2. A small portion of the dermal reticulation, exhibiting more distinctly the structure and mode of disposition of the rectangulated sexradiate defensive organs, × 80 linear.

Fig. 3 represents a small piece of the skeleton-structure of *Farrea spinosissima*, with its numerous attenuated defensive spinous prickles, × 36 linear.

Fig. 4. A small portion of the fibre of the sponge, more highly magnified, exhibiting the mode of disposition of the spinous defensive prickles coated with sarcode, × 80 linear.

6. On the large Sheep of the Thian Shan, and the other Asiatic Argali. By Sir Victor Brooke, Bart., F.Z.S., and Basil Brooke, F.Z.S.

[Received June 14, 1875.]

Captain Biddulph having shown (*antea*, p. 157) appreciable points of distinction between the large Wild Sheep obtained by the officers of the Yarkand Mission on the Thian Shan, described by Dr. Stoliczka as *Ovis poli* (P. Z. S. 1874, p. 425), and the true *Ovis poli* of Blyth from the Great Pamir, we have been induced to study all that is known of the large Argali Sheep of Central Asia, in the hopes of determining the Thian-Shan species, and of ascertaining what may be regarded as established facts respecting the differentiation and distribution of the allied forms.

This study has convinced us that our knowledge of the physical geography and fauna of Central Asia is as yet far too inexact to admit of any thing more than a mere statement of bare facts. We have therefore concentrated our efforts upon the task of placing all the facts that we have been able to gather in as easily accessible a form as possible, without attempting to estimate the exact value of characters of the origin and extent of which we at present know but little. Many of the specimens collected by the Yarkand Mission are now in London, and we have had the fullest opportunity of examining them. To Mr. Edwin Ward our best thanks are especially due for the many facilities which he has offered to us, at, we fear, considerable inconvenience, for studying the specimens committed to his charge.

By far the most important recent contribution to our knowledge of the subject before us is due to the laborious and careful researches of Mr. N. A. Severtzoff, the results of which are published in the 'Transactions of the Imperial Society of Naturalists of Moscow,' vol. viii., and also in a separate work entitled 'Vertikalnoe e Gorovontalnoe Raspredalenie Turkestankie Jevotnie' (Moscow, 1873). Unfortunately both Mr. Severtzoff's works are written in Russian, a language which is utterly unintelligible to the larger number of European and American naturalists. We feel, therefore, that no excuse is necessary for laying before the Society a more or less full abstract of all that touches the subject of this paper*.

Almost all we know respecting the Turkestan species being contained in Severtzoff's work, we shall, in treating of these species, adhere as closely as possible to Mr. Severtzoff's own words. At the end of the account of each species we will add any observations which may suggest themselves to us as worthy of notice. In the case of the species not found in Turkestan, we shall give original descriptions of specimens personally examined in either British or Continental museums; and finally we shall append a table of all the specimens which we have examined, with their measurements, followed by a list containing remarks on the individual peculiarities of each specimen, and the name of the Museum, public or private, in which it may be found.

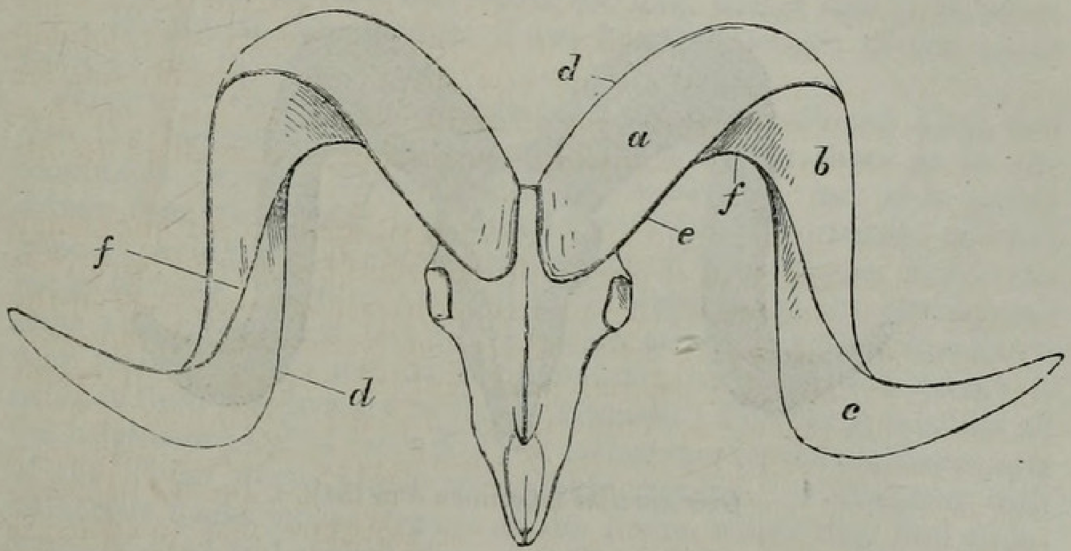
Before describing the different species of Sheep met with by him in Turkestan, Mr. Severtzoff defines clearly the terms used by him in his descriptions of the horns of Sheep; and, although we are unable to agree with Mr. Severtzoff in the value which he attaches to the characters afforded by the horns, we fully appreciate the practical utility of Mr. Severtzoff's definitions. We propose, therefore, following his example, to define as exactly as possible the features observable in an adult typical Sheep's horn, giving to each a

* Mr. Severtzoff's descriptions have been translated for us by Mr. F. Craemer.

distinct name that will not only render intelligible Mr. Severtzoff's descriptions, but may also be used in future in the comparisons and descriptions of these parts.

The horn of an adult typical Sheep is divided by three more or less distinct edges into three surfaces. Of these latter (speaking of the basal portion of the horn), one is anterior (fig. 1, *a*), one exterior (fig. 1, *b*), and one interior (fig. 1, *c*). The first-mentioned of these surfaces we propose naming the *frontal surface*, the second the *orbital surface*, and the third the *nuchal surface*. These terms

Fig. 1.



a. Frontal surface.
b. Orbital surface.
c. Nuchal surface.
d. Fronto-nuchal edge.
e. Fronto-orbital edge.
f. Nuchal edge.

appear to us preferable to the terms anterior, exterior, and interior, as, owing to the spiral twist of the horns, the relative position of the surfaces is reversed in their basal and terminal extremities. Of the two edges which border the frontal surface, one (fig. 1, *d*) is interior, forming at its origin the nearest approach of the horns; this we shall refer to as the *fronto-nuchal* edge, the other, the exterior (fig. 1, *e*), as the *fronto-orbital* edge. The remaining edge (fig. 1, *f*) we shall term the *nuchal* edge.

Further, the entire spiral of the horn may be divided into three curves:—

1. The basal curve ascends.
2. The median curve descends.
3. The terminal curve varies in direction according to the length of the horn.

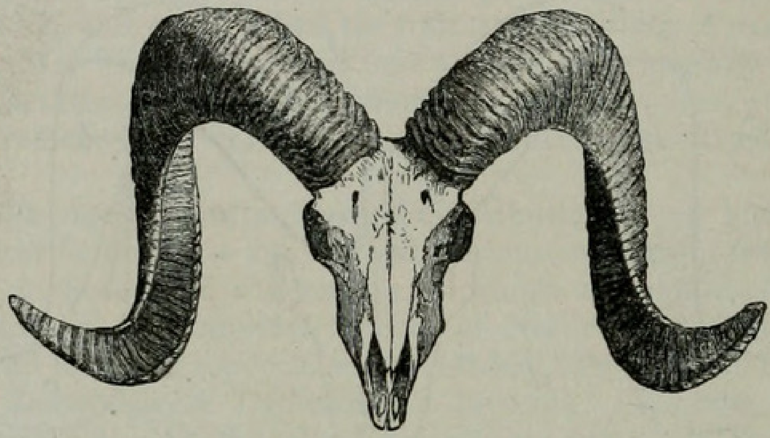
The angles formed by the axes of these curves, both with each other and with the vertical axis of the skull, have been used by Mr. Severtzoff as characters for distinguishing the different species. These we shall refer to as the basal, median, and terminal axis.

We now proceed to give abstracts of Mr. Severtzoff's descriptions of the species observed by him in Turkestan.

"Ovis kareleni. (Figs. 2 and 3.)

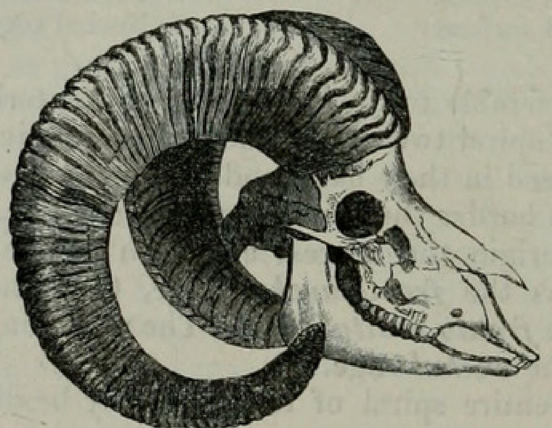
"I have named this species after the worthy explorer of Central Asia, who was also the first to obtain specimens of the species in the Ala Tau, near Semiretchinsk, about 1840. The specimens have up to the present been considered identical with *Ovis argali* (Pallas).

Fig. 2.



Ovis karelini (specimen *b* in list).

Fig. 3.



Ovis karelini (specimen *b* in list).

I have, however, upon a comparison of my two perfect specimens and the three specimens obtained by Karelin, separated this form from the true East-Siberian *Ovis argali* of Pallas. Of this latter species there are three skulls and a perfect specimen in the Moscow University Museum."

Description.—"The horns are moderately thick, with rather rounded edges; frontal surface very prominent; orbital surface rather flat, narrowing only in the last third of its length. The horns are three times as long as the skull. The basal and terminal axes of the horn rise parallel with each other; . . . the median axis is parallel with the axis of the skull. . . . The neck is covered by a white mane, shaded with greyish brown. The light brown of the back and sides is separated from the yellowish white of the belly by a wide dark line. The light brown of the upper parts gets gradually lighter towards the tail, where it becomes greyish white, but does not form a sharply marked anal disk. On the back there is a sharply marked dark line running from the shoulders to the loins. I did not find any soft hair under the long winter hair in October. . . . Height at the shoulder 3 feet 6 inches, length of the horns from 44″ to 45″."

Range.—" *Ovis karelini* inhabits all the Semiretchinsk Altai, and also the Sapliskey Altai, but is not so common there as in the mountains between Tamgali (?) and Kaskelen; but it is partly driven from this latter locality by the Cossack sportsmen, and has gone to a higher elevation, namely the Kebin Steppe, above the range of trees. East of Tamgali (?) (Turgeli ?), on the bare mountains and plains near the rivers Chilik and Kelen, *Ovis karelini* is very abundant, but not on the mountains covered with trees; it extends from this locality as far as Santash. Further it inhabits all the neighbourhood of Issik Kul; is rather rare on the northern parts of the Thian Shan, which are thickly wooded. I also met with numerous flocks in the steppes of the Narin, where they find abundance of food and shelter at an elevation of about 12,000 or 13,000 feet above the level of the sea. This species is also met with on the mountains separating the Narin from its tributary the Atpash, as far as the plains between the rivers Kurtka and Chatir Kul; but from the eastern sources of the Atpash as far as the Chatir-Kul it is found only in company with *Ovis polii.*"

Habits.—" *Ovis karelini,* like other Sheep, does not live exclusively amongst the rocks, as is the case with the different species of *Capra.* It is not satisfied, like the latter, with small tufts of grass growing in the clefts of the rocks, but requires more extensive feeding-grounds; it is therefore more easily driven from certain districts than is the case with *Capra.* In the neighbourhood of Kopal, for instance, the Goats are abundant in the central parts of the steppes of Kara, whilst the Sheep have been partially driven from these places, only visiting them in autumn.

"On the southern ranges of the Semiretchinsk Altai, in the vicinity of the river Ili, wherever good meadows and rocky places are found, *Ovis karelini* occurs at elevations of from 2000 to 3000 feet; at the sources of the rivers Lepsa, Sarkan, Kora, Karatala, and Koksa it goes as high as 10,000 feet, and even to 12,000 feet in the neighbourhood of the Upper Narin. In winter it is found at much lower elevations."

We have no hesitation in referring the specimens obtained by the Yarkand Mission to the south of Chatir Kul, on the Thian Shan, to this species. Colonel Gordon's specimen (specimen *a* of list) shows a very much greater extent of white on the lower sides and haunches than appears to have been the case in either of Mr. Severtzoff's specimens; the white anal disk is strongly defined from the rosy fawn colour of the upper parts of the back by a distinctly darker shade.

"Ovis poli. (Figs. 4 and 5.)

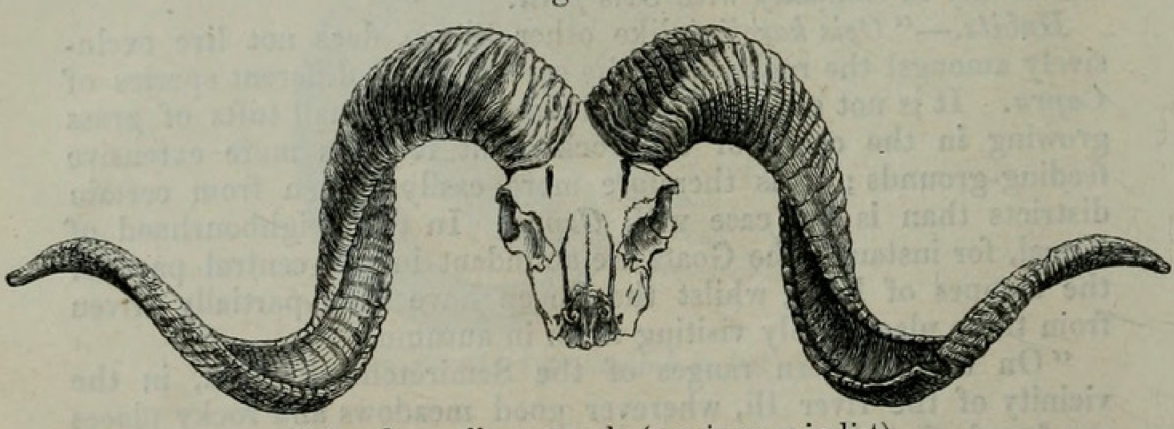
"This species was founded upon specimens obtained by Wood at the sources of the Amu Daria, on the high plains near the Lake Siri Kul, at an elevation of about 16,000 feet, consequently about the same locality as that mentioned by Marco Polo."

Description.—"The horns are very large, pressed in from the sides, the edges, with the exception of the fronto-nuchal edge, being

Fig. 4.

Ovis poli, larger example (specimen *f* in list).

Fig. 4 *a*.

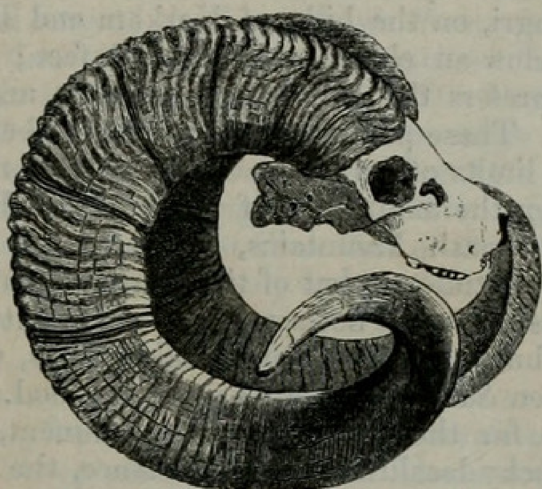


Ovis poli, smaller example (specimen *g* in list).

rounded. The orbital surface is pressed in, and commences to get narrower only during the last third of its length. The horn is more than four times the length of the skull. The basal and terminal axes of the horns are not parallel, the latter being directed more horizontally. . . . All round the neck there is a pure white mane;

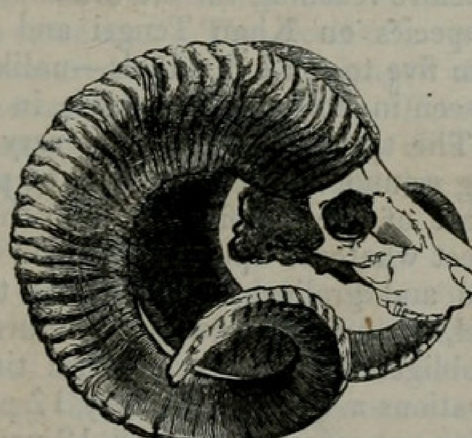
and there is a dark line along the spiral column from the shoulders to the loins. The light greyish brown of the sides shades off into white towards the belly. A pure white anal disk surrounds the tail; above this disk is bordered by a rather dark line; but below it extends largely over the hinder parts of the thighs, shading gradually nto the brown colour of the legs. I did not discover any soft short hair under the long winter hair during the month of October. Height 46″, length of horns 57″. . . .

Fig. 5.



Ovis poli, larger example (specimen *f* in list).

Fig. 5 *a*.



Ovis poli, smaller example (specimen *g* in list).

"Such is the coloration of *Ovis poli* in winter. The specimens seen by Mr. Semenoff on the Khan Tengri in summer appeared to be dark brown."

Range.—"*Ovis poli* was met with by Mr. Semenoff on the high plains near the snow-covered summits of the gigantic mountains of Khan Tengri, at the sources of the rivers Karkara, Tekes, and Sarijaws. These places form the most northern limits of its range, which to the south-west extends as far as the Narin, the upper Sir Daria, and the tributaries of the Kashgar Daria. I found skulls of *Ovis poli* within a distance of 10 or 12 versts north of these rivers, at Ulan, on the mountains of Atpash; here it lives, mixed in very limited numbers with *Ovis karelini*, this locality constituting the narrow district where the two species are found together. On the high plain of Aksai only *Ovis poli* is to be met with, where it is very abundant. Here it usually keeps in the mountains of Bos-adir, on the north shores of the Aksai, and feeds on the hilly meadows close to the river. It has, as yet, not been obtained further north.

"On Khan Tengri, on the hills of Karkara and Tekes, *Ovis poli* is not met with below an elevation of 10,000 feet; but it is here rather rare, as it prefers the grass-covered plains near the level of the eternal snow. These plains are about 11,000 feet above the sea. On the Aksai the limits of its range are formed by the river of the same name between the mountains of Kokkia and Bos-adir. It is here, as on the Atpash Mountains, found as low as 9000 feet, ranging from this altitude to that of the eternal snow."

Habits.—"This animal is not a regular inhabitant of the mountains and rocks, but of high-situated hilly plains, where *Festuca*, *Artemisia*, and even *Salsoleæ* form its principal food. It only takes to the mountains for the purposes of concealment, avoiding even then the more rocky localities, as, for instance, the Kok-kia, near the Aksai, where I only met with *Capra skyn*. Wherever *Ovis poli* has been met with, it has been found inhabiting the same localities during the summer and winter; the latter season, though cold, is remarkably free from snow, the winter clouds being intercepted by the lower mountains before reaching the elevations inhabited by the Sheep. I saw this species on Khan Tengri and Aksai in small scattered flocks of from five to ten individuals—unlike *Ovis karelini*, which species I have seen in flocks of hundreds in the neighbourhood of the Narin. The speed of *Ovis poli* is very great; but the difficulty in overtaking wounded specimens may be partly attributed to the distressing effect of the rarefied air upon the horses, which has apparently no effect whatever upon the Sheep. The weight of an old specimen killed and gralloched by me was too much for a strong mountain-camel, the animal requiring 4 hours to accomplish 4 versts, and being obliged to lie down several times during the journey. At low elevations a camel can carry 17 poods with ease, but in these lofty plains not more than 11 or 12 poods; the entire weight of a male *Ovis poli* will therefore be not less than 16 or 17 poods; the head and horns alone weigh over 2 poods."

As may be seen by a comparison of the measurements of the *Ovis poli* obtained by Mr. Severtzoff on the Aksai Plain with those of the specimens from the Pamir examined by us, the horns are of about equal length in the Thian-Shan and Pamir *Ovis poli*, but they are of considerably wider span in the specimens from the Pamir. It may, however, be possible that specimens exhibiting a much wider span are procurable in the Thian Shan than those obtained by Severtzoff. The fact of *Ovis poli* and *Ovis karelini* inhabiting the same area on the Upper Narin seems to us to indicate the probability that the difference between these two forms is not so superficial as might be at first supposed.

"Ovis heinsi.

"I have thus named this species, the first specimen having been sent me by General Heins from Tokmack."

Description.—"The horns are not massive; they are pressed in from the sides, and have three sharp edges; the inner spiral would fit on an inverted cone with the base turned toward the skull. . . . A section of the base of the horn shows the nuchal surface to be a little narrower than the orbital surface, each of these surfaces being $1\frac{1}{2}$ times as wide as the frontal surface. The basal axis of the horn and the vertical axis of the skull form an angle of about 40°, the basal with the median axis an angle of about 31°; the latter and the terminal axis form a right angle. . . . The height, judging from the skull, would be a little less than that of *Ovis karelini*. . . ."

Range.—"This species is only known from the skulls of middle-aged specimens with incompletely developed horns. . . . . These specimens were, as above stated, found in the Tokmack district, without, however, any more exact particulars as to locality. The geographical distribution of the species is therefore unknown. Some greyish brown Sheep seen by me in the Alexandrovski district, near Merke, belong, I think, to this species. They were seen at an elevation of about 8000 feet, near the rivers Katchara and Chu. Mr. Semenoff was also told by the Kirgees about these Sheep; and they could hardly, I think, be *Ovis poli*.

"The horns of *Ovis heinsi* are not much smaller than those of *Ovis poli* of the same age. The skull of a specimen of *Ovis heinsi*, aged 5 years, measured 11″ 4‴; the length of the horns is 33″ 2‴, and the span between the tips is 31″ 4‴. The same measurements in *Ovis poli* of the same age are respectively 12″ 6‴, 37″, and 35″. . . . The Kirgees people might easily mistake this species for *Ovis poli*."

"Ovis nigrimontana.

"I have thus named this species on account of its having been first met with in the Karatau or Black Mountains."

Description.—"The horns are not massive; the fronto-nuchal edge is very sharp, the other two edges are also not much rounded; the frontal surface is narrow, but prominent; the other two surfaces pressed in, rendering the edges sharp, especially the fronto-nuchal edge. A section of the base of the horn shows the orbital and nuchal surfaces to be nearly equal in width, each of them being about $1\frac{1}{2}$ times as wide as the frontal surface. The axis of the skull and the basal axis of the horn form an angle of about 38°, the median and basal axes an angle of 23°; and the angle of the terminal axis of the horn and the vertical axis of the skull is 63°. The ridges of the horn are sharp, straight, and regularly parallel with each other. . . .

"This species is, like *Ovis heinsi*, only known from skulls; amongst these is one of an adult male. Through a telescope I saw that the colour of the animal is light greyish brown, with a white belly and rump. It is considerably smaller than *Ovis karelini*;" indeed it is "one of the smallest and weakest of all the Central-Asiatic Sheep."

Range.—"This species inhabits the entire Karatau, with the exception of a few localities. It is abundant on the summits of the Buguni, on the rocks near Marnin-sas, and on the western portions of the Teranisk hills, where the numerous steep rocks and clefts near Boroldai afford them excellent security. They also occur on the summits of the Chayan Mountains; further to the west I met with the species on the rocks of the Turlansky-pereval; and, according to the statements of the people there, they are abundant also on the Min-Dielki, the highest point in the Karatau, where they ascend as high as 7000 feet. To the north-westward they are found all over the Karatau, and even at their feet, where the steppes commence, namely on the Kara-Murun hills, which are not more than 1000 feet above the level of the steppe, or 1500 feet above the sea-level."

Habits.—"*Ovis nigrimontana* keeps in very small flocks consisting of three or four individuals; they are found also sometimes single." Mr. Severtzoff attributes this to the rocky nature of the ground to which the animals have been driven by the wandering tribes of the Kirgees.

Part of Mr. Severtzoff's Table of Measurements of the Wild Sheep of Turkestan.

	Ovis poli, adult ♂.	*O. karelini*, adult ♂.	*O. heinsi*, 5-years ♂.	*O. nigrimontana*, adult ♂.
	in. lin.	in. lin.	in. lin.	in. lin.
Length from nose to tail ...	79 0	71 0	...	57 0
Height at the shoulder	46 0	42 6	...	34 0
Length of horn	57 0	44 0	33 2	38 0
Distance between tips of horns	42 0	32 0	31 4	29 6
Width of temple side of horn (orbital surface)...	6 0	5 4	4 2	4 0
Width of nape side (nuchal surface)	...	...	...	...
Length of skull	14 0	13 3	11 4	10 8

The height and length of *Ovis nigrimontana* has been calculated from the size of the skull.

We will now give descriptions of the Asiatic Argali not found in Turkestan.

OVIS AMMON.

1766. *Capra ammon*, Linn. Syst. Nat. edit. xii. p. 97.

1766. *Ovis argali*, Pall. Spic. Zool. fasc. xi. p. 20, tab. 1, 2.
1862. *Ovis argali*, Radde, Reis. im Süd. v. O.-Sib. p. 238.

Adult ♂, summer?, in Mus. Brit., received from Brandt, Mus. St. Petersburg. Locality given, Siberia (specimen *n* of list).

Hair soft and close-set, about an inch in length; the same length on neck and body. General colour of the head, neck, body, belly, limbs externally as far as the carpi and tarsi rufous brown, tinged with grey. On the face the grey predominates greatly. There is also a strong shade of grey on the upper parts of the neck and shoulders. On the lower parts of the body the rufous becomes more intense. The upper part of the tail is fawn-colour. There is no sign of a white disk round the tail, the brown of the haunches becoming merely paler on the infra-anal parts. Limbs from the carpi and tarsi downwards dirty white, clearest on the inside. Horns massive, their points of moderate length, and turned boldly outwards. (For further particulars *vide* list, specimen *n*.)

Adult ♂, winter?, Mus. Lugd., received from Brandt, Mus. St. Petersburg. Locality given, Siberia (specimen *o* of list).

The general colour of this specimen is much the same as that last described, perhaps rather brighter. A pure white disk surrounds the tail, and runs down the haunches posteriorly. The hair of the neck is slightly lengthened, but of the same colour as that of the body. The white of the anterior parts of the face, lower limbs, and posterior part of the belly is much purer than is the case in the former specimen. The horns are very massive and deeply sulcated (*vide* list, spec. *o*).

Adult ♀, season?, Mus. Brit. from St. Petersburg. Darker than the male in the same collection. An indistinct pale disk surrounds the tail. Horns 20½″ long, 7″ in circumference.

Adult ♂, autumn?, Mus. Amsterdam. Locality given, Northern Asia (specimen *p* of list).

Centre of back hoary; lower parts of body brownish grey. The rump is white, but the white does not surround the tail so as to form a disk. Hair on the neck not longer than that on the body.

Range.—The range of this species appears to be of great extent; but its boundaries are as yet most uncertain. Radde, in his 'Reisen im Süden von Ost-Sibirien,' published in 1862, p. 239, thus writes:—"Since the winter of 1831–32, the Argali has not been met with on the Daurian frontier, and it is also extinct in East Siberia." And again, at p. 241:—"The Argali avoids damp wooded mountains; it is wanting in the Kentei and Southern Apfel Mountains. This latter, as well as the adjoining Chingan and Bureja ranges, and indeed the greater part of the Stanovoi Mountains, appear to possess no representative of the genus *Ægocerus*. . . . To the Birar Tunguses, as well as to the Daurians, who possess information of Eastern Mongolia as far as Dalai-nor, was the Argali Sheep known only by name. In entire Russian Dauria, as well as in the Baikal Mountains, the hunters could tell me nothing of the occurrence of either the Argali or *Ægocerus sibiricus*. To the far south of Kentei is the Argali first met with, from which place the Cossacks of the frontier stations

Altansk, Bukukun, and Kirinsk sometimes obtain skins by barter. This is also the case in Eastern Sajan. The Cossacks of Tunkinsk exchange with the Darchates the skins of *Antilope gutturosa* and of the Argali, of which species I saw skins at Schimki. It is also known to the Sojotes and Burjätes of the Upper Irkut."

According to Severtzoff the Argali does not occur in Turkestan; but he believes that it ranges "to the east of the desert of Gobi over the mountains of the Upper Salenga, Higan, where it has been met with, and probably further south over the Inshan, and about the sources of the two great Chinese rivers. This will either be proved or negatived by Mr. Prjevalsky, who is now exploring this part of the country." Mr. Severtzoff appears to be uncertain as to whether the Sheep bearing the name of Argali which inhabits the low hills of the Siberian Kirgees steppes of Karkalinsk, Orkatsk, and Aldgan-adersk belong to this species or not.

OVIS HODGSONII. (Figs. 6 and 7).

1833. *Ovis nayaur* or *argali*, Hodgs. Asiat. Res. vol. xviii. part 2, p. 133 (part).

1840. *Ovis hodgsonii*, Blyth, P. Z. S. p. 65.

1841. *Ovis ammonoides*, Hodgs. Journ. Asiat. Soc. p. 230, pl. 1.

1860. *Ovis hodgsonii*, Sclat. P. Z. S. 1860, p. 129.

Adult ♂, winter, Colebrooke collection. Obtained within 30 miles of Leh in the winter of 1873 (spec. *u* of list).

Hair of body about 2 inches in length, coarse and close-set. On the sides and lower surface of the neck the hair is lengthened into a long rich ruff-like mane of a snow-white colour. Along the median line of the upper neck there is a narrow band of rather shorter hair,

Fig. 6.

Ovis hodgsoni (specimen *x* in list).

which, however, is about twice as long as that on the body, and, being continued as far back as the withers, forms a short dorsal mane. General colour of the body dark brown, mixed with grey. Anterior parts of the face, belly, limbs below the carpi and tarsi