suggestive of the internal lace-like layers of the bark of the tree in question. The following will serve as a brief technical *résumé* of the two new genera and species here introduced; each of these latter standing at present as the sole representative of its genus, the characters embodying the genus will also be inclusive of the species.

Subclass *PORIFERA SILICEA*, J. E. Gray.

Order ARMATOSPONGIÆ, *ib.*

Fam. **Esperiadæ**, *ib.*

Gen. nov. RHAPHIDOTHECA.

Sponge incrusting, cavernous interiorly; entire external surface of cortex bristling with spinulate spicula having their attenuate apices directed inwards and mingling freely with the fascicles of simple acerate spicula which form upright supporting pillars to the roof; fascicles of smaller acerate spicula abundant in the sarcode of the cortex, and also distributed less frequently in the basal layer of sarcode, and in that investing the shafts or pillars; in the latter, also, minute spicula of the "palmato-inequianchorate" type (Bowbk.). Oscula absent or indefinite.

R. Marshall-Hallii, ib. Pl. XV. figs. 1–7.

Hab. A depth of 500 fathoms ten miles off the shore of Cezimbra, Portugal; attached to *Lophohelia prolifera*.

Order CORALLIOSPONGIÆ, J. E. Gray.

Gen. nov. FIELDINGIA.

Sponge adherent, consisting of a cortex of irregular reticulated spicula, having on its interior surface numerous reticulated laminæ of extremely delicate consistence. Common cavity of the sponge containing numerous spherical aggregations of spicular reticulations; these invested and brought into relation with the cortex by loose reticulated fibres of coarser structure, having a general hexradiate arrangement; these fibres cylindrical, and to a considerable extent minutely and erectly spined; frequently attached to them very diminutive spicula of the "rectangulated hexradiate" type, these also minutely and erectly spined. Nutritive and exhalant functions most probably performed through the general reticulations of the cortex.

F. lagettoides, ib. Pl. XV. figs. 8–15.

Habitat and associations similar to the last.

Affinities of the described Species.

Rhaphidotheca Marshall-Hallii, on account of its possession of simple acerate, spinulate, and bianchorate spicula, and the non-existence of pronged, uncinate, or stellate forms (characteristic of the Tethyadæ), falls naturally into the family Esperiadæ of the Armatospongiæ of Dr. Gray. The characters of the spicules alone suggest its close affinity to the genus *Esperia* (O. Schmidt) itself; but the general contour of the sponge-body, and the relationship of the respective forms of spicula to the same, forbid its being embodied in it. The only illustration of an approach to the peculiar vaulted character of the interior cavity of this sponge is exemplified in a portion of the form figured and described as *Ciocalypta penicillus* by Dr. Bowerbank in his 'British Spongiadæ;' the other characters of that sponge, however, are totally different. *Tethya spinularia* (Bowbk.) would also seem to show certain affinities, and especially in the presence of fasciculi of small acerate spicula, and in the possession of spinulate forms; but this last spinulate type, instead of being confined to the cortex, are distributed through the various regions of the sponge: this and their peculiar form ("ovo-spinulate," Bowbk.) would suffice to demonstrate the specific difference between Dr. Bowerbank's species and my own; while the massive character of the sponge-body of the former, and its well-developed oscular system, further demand its generic separation. I would, moreover, venture to suggest that the time has now arrived for the separation of *T. spinularia* from the Tethyadæ proper, the characters of its spicula denoting the necessity of referring it to the Esperiadæ, and also in all probability to the type genus of that family.

Regarding the new genus *Fieldingia*, in the present limited state of our knowledge of the Coralliospongiæ, it seems difficult to establish any immediate bonds of affinity. *Thionella* (Dr. J. E. Gray, Proc. Zool. Soc. 1868), however, in the more massive character of its cortical layer, and in its internal reticulated structure, indicates a distant resemblance, yet closer than is to be found in either *Habrodictyon*, *Hyalonema*, *Euplectella*, *Aphrocallistes*, *Dactylocalyx*, *Farrea*, *Macandrewia*, or *Pheronema* (*Holtenia*, Wyv. Thomson), the remaining genera of the order with which we are at present conversant.

EXPLANATION OF PLATE XV.

Fig. 1. *Rhaphidotheca Marshall-Hallii*, nat. size, adherent to a piece of *Lophohelia prolifera*.

Fig. 2. A section of the same, showing the vaulted internal structure,

magnified 2 diameters. The dark line *c* indicates the boundary of the coral.

Fig. 3. Two of the upright supporting pillars, with a portion of the cortical layer or roof, showing the relationship of the pin-head or "spinulate" spicule, × 25 linear.

Fig. 4. A group of the small acerate spicula which occur principally in the cortical and basal investing layers of the sarcode, × 100 linear. 4 *a*, a few × 250 linear.

Fig. 5. One of the larger acerate spicula which enter into the construction of the upright supporting pillars, × 50 linear.

Fig. 6. Spinulate spicula of the cortex: *a*, the ordinary form; *b*, upper portion of one with head somewhat depressed, × 60 linear.

Fig. 7. "Palmato-inequianchorate" spicula of the sarcode, × 250 linear. The top figure is an example in profile.

Fig. 8. *Fieldingia lagettoides*, in section, nat. size, showing the spherical bodies with their radiating fibres contained within.

Fig. 9. One of these bodies isolated, with the investing and radiating fibres × 15 linear: at *a* and at various other parts the minute "rectangulated hexradiate" spicules are depicted.

Fig. 10. A smaller one attached to the inner layer of the cortex. The upper part of the figure illustrates the finer reticulated laminæ of the cortex, while below is shown a looser reticulation which usually intervenes between the former and the coarser network of the internal cavity, × 10 linear.

Fig. 11. A transverse section of a small spherule, illustrating the internal reticulated structure, × 40 linear.

Fig. 12. An isolated fragment of this internal reticulation, × 100 linear.

Fig. 13. The general cortex in transverse section, × 10 linear.

Figs. 14 & 15. Fragments of the inner reticulated laminæ, × 50 linear.

XXI.—*Description of a new Species of* Seïsura.

By John Gould, F.R.S.

Seïsura nana, Gould.

Head glossy greenish black; back and tail the same, but somewhat lighter; wings brownish black, the secondaries with paler edges; under surface white, tinged with buff on the chest; bill and legs bluish lead-colour.

Total length 6 inches; bill $\frac{3}{4}$, wing $3\frac{3}{4}$, tail 3, tarsi $\frac{3}{4}$.

Habitat. Northern Australia.

Remark. In form and colouring this species is very similar to *Seïsura volitans*; but it is so much smaller as to preclude the possibility of its being identical with that bird. It was received from Mr. Waterhouse of Adelaide, South Australia, accompanied by a *Limosa uropygialis* in the red or summer plumage, and some other species common to the northern part of the country.

XXII.—*On some new Fundamental Principles in the Morphology and Classification of* Rhynchota. By Professor J. C. Schiödte*.

I.

In all the large independent works, as well as in the numerous minor treatises, by which Latreille has founded the natural system of the articulated animals, there is an undercurrent of merely indicated scientific views, which he has abstained from working out, either because time and material failed him, or because he lacked the necessary courage and confidence in his own ability to get over some mistake of observation, often an entirely accidental one, which had stopped his progress. Thus, for instance, his exceedingly ingenious theory of the "segment médiaire," which, rightly understood, solves so many hard morphological knots, and is of such comprehensive and useful application in classification, has had the fate of being rejected by such anatomists as Burmeister, Westwood, Straus-Dürckheim, Lepelletier de St. Fargeau, Newport, Spinola, and Lacordaire, only because he was unable to supply that conclusive element which was required to give it scientific certainty and support it by decisive proof—namely, the demonstration of the apparently missing pair of spiracles between the second and third thoracic rings in *Piezata* †. There are other cases where Latreille has incidentally pointed out the importance of certain features in the structure of insects which are more easily investigated, and where these indications, which the great French naturalist had left undeveloped, have been investigated by subsequent authors; but they have rarely done more than accumulate descriptive details. As an example we may adduce a passage in 'Le Règne Animal' (nouv. éd. 1829, tom. iv. p. 306), where, after having treated of the relation between the epimera and the segments of the body, he continues in this manner:—"Les relations de ces parties, la grandeur et la forme du premier article des hanches, la manière dont elles s'articulent avec le demi-anneau dont elles dépendent, l'étendue et la direction de ce demi-anneau variant, le thorax considéré sous ce point de vue, présente une combinaison de caractères, qui est très avantageuse pour la méthode." The indication of the differences in the mode of articulation of the limbs with the body which is contained in these words was never more fully

* Translated from 'Naturhistorisk Tidsskrift,' ser. 3, vol. vi. 1869. Copenhagen.

† See 'Proceedings of the Royal Danish Society of Sciences, 1856, p. 135.

developed by Latreille. Later zootomists and systematic authors, particularly Spinola and Erichson, have certainly occasionally turned their attention to the coxæ of Eleutherata, and distinguished between coxæ globosæ, transversæ, and conicæ. But these distinctions, which only take into consideration the external form, are in themselves superficial, and lack the desirable sharpness and certainty of application, even when considered from the merely descriptive and diagnostic point of view—because coxæ globosæ, by a gradual elongation downward, insensibly become coxæ conicæ, and by lateral extension at last coincide with coxæ transversæ, whilst the latter, when inclined inwards and downwards, become undistinguishable from coxæ conicæ. Besides, coxæ of each of these forms may be more or less moveable, and there is an insensible transition between those which are deeply inserted into sockets of articulation and those which are more superficially fixed; in consequence of which the distinction which now and then is made between coxæ fixæ and coxæ mobiles, not only does not state any thing about the mode of movement, but is without connexion with the distinctions made with regard to form. These distinctions, therefore, however useful they may be within a limited systematic division, do not touch the central point of the question, which I hope to be able to place in a clear light by the following considerations.

The limbs of Articulata articulate with the body in two principal ways, corresponding to two fundamental forms of coxæ—*coxæ cardinatæ* and *coxæ rotatoriæ*.

*Coxæ cardinatæ** are either immoveably connected with the body, or they can only be moved slightly from side to side, or backwards, in the direction of the longitudinal axis of the animal. The mobility being reduced, the epimera and the sternum, which are intended to contain the muscles serving for the movement of the coxæ, are correspondingly reduced in size, whilst the coxa itself, which in this case alone has to accommodate the muscles which move the remainder of the leg, becomes more expanded and capacious in the same proportion. Where powerful movements are executed in a horizontal plane, by which the leg at the same time describes a large arc, particularly in running or swimming, the large coxa is furnished with a groove (scrobiculus femoralis) on its external surface, in order to obtain space for the bending forward of the leg.

Coxæ rotatoriæ can be turned round their own longitudinal

* This expression is borrowed from Vitruvius (in the paper "De aliis testudinibus," Schneider's edition, i. 301).

axis. In this case the muscles which move the coxæ always demand more space, and in the same proportion the epimera and the sternum are increased in size. The coxa itself being rendered more independent of the neighbouring parts by its greater mobility, may and does vary considerably in size, but retains always a rounded shape, and is always fitted in a deeper socket. In legs serving the purpose of walking, the rotatory coxa is frequently very small and reduced to a mere node of articulation for the remainder of the leg, whilst its size is often very considerable where the legs are used for running or swimming, and still more in fossorial legs. In the former case the coxæ will be separated by a considerable interval, and placed so near the sides of the animal that the movement of the leg becomes sufficiently clear of the body; and no groove will then be necessary for facilitating the bending forward of the leg. But in the latter case the coxæ must meet in the middle, as the large cursory and natatory forms of coxæ cardinatæ; and a groove will then be necessary also in the case of coxæ rotatoriæ. Typically, however, this combination is as much calculated for walking as that of the coxæ cardinatæ is calculated for running, springing, and swimming.

Both forms of coxa may occur in the same animal, particularly in this way—that only the foremost or some of the foremost pairs of limbs have rotatory coxæ. When those limbs which serve for the progression of the animal have cardinate coxæ, the animals may be described as *Pagiopoda*; but when the progression of the body depends on limbs with rotatory coxæ, we may describe them as *Trochalopoda*.

The great majority of Articulata of all three classes are *Pagiopoda* in a great variety of modifications, in many cases affording excellent characters for natural divisions, which have not yet been made use of, but which cannot be further explained in the present treatise. A considerable number of Eleutherata and Rhynchota are *Trochalopoda*; and it is with regard to the latter of these orders that the whole subject has been mooted here, because, when combined with certain other elements of structure which have likewise hitherto been overlooked or not rightly interpreted, they may serve for a more natural classification than that which has hitherto been adopted.

II.

The classification of Rhynchota stands in scientific respects still at the same point at which it was left by its founders, Fabricius and Latreille; it is scarcely possible to point out any new or fruitful idea which has been applied to it since.

At the same time, this order has, during the last two or three decennia, been worked up with predilection by a number of specialists, to whose untiring and in part very meritorious exertions we are indebted for an astonishing increase in the number of described species. The isolated merely descriptive treatment of the contents of the different museums, however, has had its usual consequences: the classification has become a mere register of specific characters; the distinction between its categories has been rendered evanescent; and it has ceased to reflect the typical unity of the morphological variations. So far from the true understanding of the structure and life of the animal having been furthered, the state of our knowledge, on the contrary, as may be seen by consulting the newest and most used manuals, has receded several steps behind the standpoint to which the leading works of thirty years ago had brought it. In the following, however, we shall confine our investigation of the present classification to those cardinal points which come into consideration in establishing the scheme which we propose.

The very first point in the morphology of Rhynchota, which is of primary systematic importance, is erroneously stated by all the authors that I am acquainted with.

The two natural suborders Homoptera and Hemiptera are in their whole habitus so distinct that even the most superficial investigation cannot fail to appreciate their difference; and the perception of these two suborders can be traced in the writings even of the very earliest naturalists. But it was found that a suitable diagnosis of their difference could not be obtained by means of the changeable forms of the wings; and it was then proposed to distinguish them by means of the place of insertion of the rostrum, which was supposed to be fundamentally different in the two orders, of which accordingly one, the Heteroptera, often were described as *Frontirostria*, whilst Homoptera were described as *Gulærostria*. In the former case the rostrum was supposed to take its origin from the epistoma, in the second case from the underside of the head—hypostoma. This view is undoubtedly at variance alike with common sense and the first elements of a scientific appreciation of the structure of the head in Articulata. It is true that it has been adopted by men of scientific spirit and knowledge, like Latreille, Dufour, Burmeister, and others, who cannot possibly have been ignorant of the fact that the parts of the mouth in all cases have their basis on morphologically the *same* parts of the head, whatever position these parts may occupy in the general outline of the animal, according to the exigencies of its structural combinations. But these zoolo-

gists evidently thought that they might content themselves with treating the matter from the point of view of simple horismology, and that, at any rate, the distinction practically worked so well that a morphologically true character might be dispensed with, just as ichthyologists are content to say that the mouth in Sturgeons and Plagiostomata is placed on the under surface of the head. But the fact is that the definition does not hold good even if it is understood in a purely horismological sense—that is, even if the parts are named without regard to their morphological value. Between the structure of the *Reduvii*, where the rostrum appears as an immediate continuation of the top of the head, and that of *Cicadæ*, where it closely adjoins the prosternum, there is a series of insensible transitions, represented by the swimming species, as well as by many living on the land, such as the *Platycephala*; and the whole question about the so-called position of the rostrum resolves itself into this, that the forehead is more or less bent in under the head. The distinction hitherto supposed to be expressed in the position of the rostrum is as untenable as that derived from the wings; and the diagnoses of the two suborders have become so loose and indefinite, and, by additional explanations and restrictions so prolix, that, in the new manual of Fieber on the European Rhynchota-fauna (a volume in large octavo), they fill respectively nine and sixteen closely printed lines in small type. There is evidently here a serious defect in our knowledge. Unless a clear and well-defined mark of distinction between the two suborders can be found which is connected with their mode of life and expresses a morphological difference, it is far better to unite them: the present uncertain and tentative mode cannot satisfy any body.

It is evident that the rostrum must correspond to the food. But the sharply defined varieties of form and the manifold combinations of division of labour which solid food, by its varying degree of resistance to prehension, division, and deglutition, necessitates in the appendages of the mouth are, as a matter of course, only to a small extent observable in Rhynchota, which only live upon organic juices, animal or vegetable. The rostrum naturally varies to some extent in strength, length, curvature, stiffness, &c., according to the nature of the surface which has to be perforated before the nutritious liquid is reached; but we cannot expect to find any sharp lines of demarcation between these different forms, because when the animal has got hold of the body to be perforated, the work to be performed by the pungent instrument will always be essentially the same. But it is quite different with those organs which are to enable the animal to find the suitable surface,

reach it, and get it in its power. Whether the animal runs about hunting living game, and keeps it by force whilst sucking out its blood, or slinks from place to place as a parasite on the skin of another animal, or remains immovable for days and weeks on the same part of a plant, in lazy sociability, and fills itself with the juice, these are differences in the mode of life which must be accompanied by corresponding differences in the organs of sense and movement; and we find accordingly that Rhynchota vary in this respect to a very great extent, whilst they exhibit a striking uniformity in the structure of their mouth. Similar conditions of life occur in Antliata. But whilst in Antliata the structure of the imago, on account of the complete metamorphosis, is more exclusively calculated to serve the propagation of the species, the structure of the adult animal in Rhynchota is equally determined by the exigencies of the propagation of the species and the nutrition of the imago itself. Hence arises the overwhelming, teeming multitude of different forms, in which Rhynchota surpass all other orders of insects, and which renders the interpretation of their morphology and their classification a task of so great difficulty and intricacy that entomologists have preferred to evade it instead of attempting a solution of it, and carried the subdivision so far that their efforts at recognizing the types of these animals have ended in the suicidal result of considering very nearly each species to represent a generic type by itself. But although, as we have just explained, such variation in the structure of the mouth as we meet with in animals which catch and masticate their food by means of the appendages of the mouth cannot be expected in sucking animals like the Rhynchota, it cannot, on the other hand, be supposed that the great difference which upon the whole must exist between animals which exclusively live on vegetable juice, such as exclusively feed on animal juices, and those, finally, which partake of both kinds of nourishment, would not, in the midst of all this richness in form, be marked by some decisive and distinctive anatomical feature. More particularly we may confidently assert that the quiet expanded surface of the plant demands quite other properties in the structure of the Rhynchoteous animal than the sharply defined, plastic, rounded body of the living animal writhing and turning about under the attack of the blood-sucker. In both cases strength in directing the thrust of the rostrum is required, particularly in the former case; but there is one provision required by the blood-sucker, which would be most injurious to the sucker of vegetable juices; and that is, facility in changing the aim of the rostrum during use, particularly as many blood-suckers

first kill and then suck, and consequently must often repeat the thrust. In this latter case the whole figure must be slimmer, the head smaller and susceptible of lateral and rotatory movements, whilst the shape of the head and rostrum for the rest may vary very considerably according to the nature of the prey. But in the former case the general figure of the animal will naturally be shorter, more thick-set; the head, more particularly, will be larger, because it is to accommodate the more powerful muscles required for penetrating the firmer vegetable surface; while at the same time there is no need of the head being capable of turning to the side or round its longitudinal axis, nor is there any occasion for considerable variations in the form of the head or the rostrum, as these animals can always assume essentially the same position in the act of perforation and suction.

The blood-suckers, moreover, require principally fitness for running and walking, whilst those which live on vegetable juices want adaptation for springing and flying. On closer examination, this circumstance will supply us with the true key to that difference in habitus between Heteroptera and Homoptera which has been dimly recognized almost from the beginning, but which entomologists have not yet been able to express satisfactorily in their diagnoses, though in practice they have rarely erred in referring any particular species to one or the other of these suborders. The reason why the difference in question has not yet found a satisfactory expression in systematic diagnoses, is this—that in proportion as the Heteropterous type is accommodated for subsistence on vegetable juices, it is as it were veiled by an imitation of the Homopterous cicadarian type. The main point is, that in the phytophagous type of Rhynchota the head is so modified in shape as to enable it to receive support from the prothorax; for the thrust of the rostrum cannot be executed with collective force if it is directed out from the body of the animal; the requisite force is obtained only when the thrust is directed inwards, supported by the weight of the animal and its firm footing on the surface in question. Therefore the rostrum is always directed backwards; and when the animal is to become exclusively phytophagous, special arrangements become necessary in order to render this direction the only one possible, so that the whole power may be concentrated in this direction only.

The broad and flat form of the head of the *Cicada*, which is *not* capable of turning, is *imitated* by the head of bugs, which are not exclusively blood-suckers, although their head is always capable of turning. The imitation consists in this, that the

head, without augmentation of its inner capacity, is increased in size by expansion of its margins—a plan which entails similar expansions of the prothorax and, at least in part, of the following body-segments. In such bugs as, for instance, *Cimices* and *Corei*, including *Tingides* and *Aradi*, head, thorax, and abdomen may have the appearance of considerable size, and a shape reminding one of the *Cicadæ*, whilst, in reality, with regard to space for the soft parts of the body, they are not larger than the slimmest *Reduvii*. But in spite of the expansion of the margins, the lateral and rotatory movements of the head, which are conditions of carnivorous habits, are not much curtailed, because the neck retains its shape. In Homoptera this is different: the head is really as large (that is, as capacious) as it appears outside. Here, then, we have got at a fundamental difference, which may be obscured to the more superficial consideration, but which in its nature must be thoroughgoing, and which in reality expresses itself with all desirable sharpness in a certain feature of external structure. In order to cause the two contrary movements, viz. the pressing backwards of the head and the rostrum and the pressing forwards of the body, to cooperate under the most favourable conditions by the diminution of the distance between their starting-points, the forehead is bent so far in under the animal that a struggle for space, so to say, arises between the head and the fore legs, which only can be solved by a compromise, namely thereby, that the coxæ of the fore legs to a certain extent are accommodated in the head, in excavations of the cheeks, which consequently, though it sounds absurd, really take part in the formation of the articular socket of the first pair of coxæ. By this arrangement it becomes, of course, impossible for Homoptera to turn their head during perforation or suction; they are unable to do more than to raise or depress it a little. In Heteroptera no such thing takes place, however broad and flat their head may appear: the cheeks only reach to the prosternum, but never so far as the front legs, and the head therefore retains its capability of turning on the protracted cervical process. These facts, then, lead to the following diagnosis of the two suborders:—

Homoptera. First pair of coxæ articulate with the cheeks.
Heteroptera. Cheeks and first pair of coxæ do not touch each other.

III.

All Homoptera are Pagiopoda and phytophagous; they exhibit a great variety of forms, which, however, all range

themselves into one series, proceeding without lateral branches from *Cocci* to the true *Cicadæ*, in one and the same direction, the lowest stage being characterized by sedentary habits (with propagation during summer without previous development of sexes), the higher ones by different degrees of freedom of movement—particularly springing and flight, and various combinations of these two modes of movement, which necessitate special developments of head and thorax as instruments of balance, causing the fantastic appearance of many Fulgoridæ and Membracidæ.

Amongst Heteroptera, on the other hand, some are exclusively blood-suckers; others subsist both on vegetable and on animal juices; and they exceed therefore the Homoptera in variety of form. Some are Trochalopoda, others Pagiopoda.

The coxæ of trochalopodous Heteroptera are round and, at least on the outer side, embraced by a projecting margin of the metathorax, which corresponds to their outline, whereby a proper socket is formed. These Trochalopoda comprise two great divisions—those which feed on mixed food, and the pure carnivora.

A. *Trochalopodous Heteroptera living on mixed food.*—The tendency to expansion and thick-set structure which we have explained above as characteristic of phytophagous habits, shows itself here, even in the slenderest species, also in the metathorax, which has the appearance of a plate, of which the posterior margin forms a projection of varying extent, beyond the first abdominal segment. By degrees, as carnivorous habits prevail, the lateral edges of the body are less expanded, and we observe a gradual transition from the short angular bug-type with elliptic transverse section to the elongated oval shape with even lateral margins and increasing depth of body. This series of bugs has been broken up by systematic authors into a number of small families, mostly based on general habitus, but in part also based on the number of joints in the feet and in the rostrum. But the number of tarsal joints may be different in species otherwise nearly allied, and the tube of the rostrum is in reality four-jointed in all Rhynchota; when they are sometimes said to have a rostrum of a less number of joints, this really only means that the basal joints are small, partly hidden by the projecting parts of the forehead, and not counted. I consider it far more natural to determine the steps of this series by the position of the antennæ, which depends on the different degree and the direction of the expansion of the head—that is, by the marks pointed out by Fabricius and Latreille,—the antennæ being either inserted

under the margin of the forehead or free at their insertion, and in the latter case inserted either at the top of the head, in the same line as the eyes, or below the eyes on the sides of the head. Thus we arrive at three large families—*Cimices* (with *Tetyræ* and the fossorial group of *Cydnini*), *Corei* (with *Aradi* and *Tingidæ*), and *Lygæi*. It is only within the latter family that predatory habits so far predominate that the first pair of limbs are sometimes developed into instruments for catching the prey.

B. *Purely carnivorous trochalopodous Heteroptera.*—The whole structure is calculated for freer movements; the projecting margin of the metathorax is wanting, and the root of the abdomen is entirely *uncovered*. The first pair of legs are generally adapted for catching the prey. This series of bugs, too, has been divided into a number of small families, and they have in part been mixed with those of the preceding series and with Pagiopoda. This group may naturally be divided in a manner corresponding with the local circumstances of life. *Reduvii* (with *Syrtis* and *Nabis*), which live on dry land, have terminal claws; *Hydrometræ*, which run on the surface of water, have the claws inserted above the point of the foot, and are, at least on the ventral surface, clothed with an aëriferous felt. Both families consist of animals living in atmospheric air, and have free antennæ and spiracles. Those of the third family, *Nepæ*, climb or row under water, and have short antennæ hidden under the cheeks; their spiracles are by special contrivances secured against the entrance of the water; and the last pair is transformed into a long respiratory tube.

The triangular posterior coxæ of the pagiopodous Heteroptera join the metathorax with the whole of their open base, and occupy its posterior margin; they reach, consequently, as far out to the sides as the metathorax, but a part of their real extent is sometimes hidden by the margin of the metathorax forming a flat projection which covers their external part, without, however, embracing the coxa as in Trochalopoda. The Pagiopoda are all blood-suckers. From the morphological point of view, these, therefore, repeat the series of forms observed in Trochalopoda—but with this difference, that the basis of the abdomen is naked. Recent authors, not being aware of the important character which binds them together, have split them into a great number of small families, and mixed them up with Trochalopoda. According to the localities in which they live, they are divided into:—*Acanthiæ* (*Capsus* and *Miris*, *Anthocoris*, &c., and *Xylocoris*, *Salda*, *Leptopus*), with free antennæ; *Pelegoni*, living on shores, with hidden

antennæ and cursorial limbs; and swimming-bugs, with hidden antennæ and swimming-legs. The latter are again divisible into those which swim on their back (*Notonectæ*), boat-shaped, and with free rostrum, and those which swim in the usual position, which again are divisible into *Naucorides*, with free rostrum and free metathorax, *Belostomata*, with free rostrum and the sides of the metathorax covered by the overreaching lateral parts of the mesothorax, and *Corixæ*, with hidden rostrum and free metathorax. The family of *Acanthiæ* comprises species indicating, so to say, the developments of the type into the other families: *Pelegoni* more particularly are indicated by *Salda*. For the rest, it is still doubtful whether *Pelegoni* and *Naucorides* can be sharply distinguished from each other.

In trochalopodous as well as in pagiopodous Heteroptera, the articulation of the abdominal segments is in the same degree more moveable as the structure is more exclusively calculated for carnivorous habits, particularly when the animal lives under circumstances which in themselves require greater flexibility of the body, for instance, in the water, or hunting on plants; but if it seeks its prey on an open and even surface, the abdomen may be as inflexible as in suckers of vegetable juices. Thus the joints coalesce along the middle of the ventral surface, not only in many *Cimices*, but also in many *Reduvii*. In many *Lygæi*, in *Nepæ*, *Nabis*, *Anthocoris*, &c. the edges of the anterior segments meet on a level, whilst the posterior segments are imbricate; but in *Capsi* all the joints are imbricate, and the whole abdomen very moveable, &c. These differences afford in several instances useful marks for groups and genera.

The Rhynchota, which live as parasites on warm-blooded animals and possess a telescope-formed rostrum, are pagiopodous, but must, in accordance with their general structure, be treated as a separate division, *Siphunculata* (Latr.), of equal value with Heteroptera and Homoptera.

IV.

The classification to which the views explained in the foregoing necessarily leads entails, in several respects, such a thorough revolution in the hitherto received arrangement, that it can scarcely look for ready and immediate acceptance by hemipterologists. But nothing will offend them more than the demolition of the division of Cryptocerata, which hitherto has been looked upon as irremoveably established. This division as now accepted is remarkable for uniformity in general appearance, and possesses an easy and decisive character in the short and hidden antennæ; it will there-

fore, first of all, be objected to my classification that it dissolves a natural division which has been long recognized as such, and that it does away with the generally accepted distribution of Heteroptera in *Geocores* and *Hydrocores*. My answer is that Cryptocerata (*Pelegoni*, *Nepæ*, *Naucorides*, *Corixæ*, *Notonectæ*) are not united together except by features which are connected with their life under water, and that *Nepæ* on the one side, and *Notonectæ* and the other families on the other side, are not less different from each other in all points of their structure than *Dytisci* and *Hydrophili* amongst Eleutherata. In *Nepæ* the posterior limbs are moved alternately, as in *Hydrophili*; like these latter, they crawl and climb and row about; and in both families peculiar modifications of certain organs are required in order to facilitate respiration—in *Hydrophili* of the antennæ, in *Nepæ* of the last pair of spiracles: in *Naucorides*, *Corixæ*, and *Notonectæ*, on the contrary, the movement of the posterior limbs is isochronic, as in *Dytisci*; they are like these typical swimmers; and no special arrangements are required for the sake of respiration, as the surface of the water can always be reached without difficulty, not to mention that the highest-developed water-bugs swim with the ventral surface upturned. I anticipate an objection to this—namely, that Cryptocerata show themselves to form a natural division in the structure of the thorax, being the only division of Heteroptera with separate epimera. But this is simply an error: Cryptocerata have undivided thoracic segments like all other Rhynchota; a real open seam between sternum and epimera is never to be found. Nor is it difficult to trace the origin of the mistake. The fact is that each group of muscles belonging to the limbs moulds that part of the thorax to which it is attached into a separate form; and the lines of demarcation between these divisions project internally in proportion as the muscles are stronger; these boundary-lines appear outside as slightly impressed lines, and, on account of their thickness in the depth, they appear with a darker colour when the background is light. The water-bugs, being supported by the medium in which they live, do not require such thick integuments of the thorax as those which live on dry land; their colours are never very dark, never metallic, but generally grey or yellow, in consequence of which the integuments are more even, smooth, and lamelliform than in land-bugs, and the boundary-lines between the parts occupied by different sets of muscles far more striking to the eye. It is likewise an erroneous appreciation of facts when it is stated that the metathorax in *Corixæ* is furnished with "parapleuræ" (that is, epimera separate from episterna); for the coxæ do not at all articulate with

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