yellow spots, much larger than those on the upper surface; pectus yellowish, venter white. Expanse of wings 57 millim.

Viti Islands.

Allied to *B. teutonia*, but readily distinguishable by the absence of orange colouring from the under surface.

4. *Ismene bilunata*, sp. n.

Wings above dark fuliginous brown, growing considerably paler towards the base, where there are a few greenish opaline hairs: primaries with two semitransparent white crescents placed obliquely before the middle of the median interspaces; fringe of all the wings tipped with white: body above greyish brown, the head and prothorax shot with opaline green; palpi sordid white, with a black external lateral line and black terminal joint. Wings below mouse-brown, primaries with the median area blackish, especially towards the base; crescentic markings as above, apical area greyish, bounded internally by a transverse elbowed lilacine whitish streak: secondaries crossed beyond the middle by a rather narrow and nearly straight white stripe, which is interrupted towards its posterior extremity by a large black quadrate anal patch; a slender white stripe at the base of the fringe, beginning at the black patch and running a short distance upwards towards the apex, but gradually fading away long before it reaches it: abdominal area faintly glossed with pink and green tints; pectus greyish; the femora white above, grey at the sides; tibiæ and tarsi grey above and more or less ochreous below; venter creamy white, barred with pale grey. Expanse of wings 52 millim.

Viti, "Koro" (? Goro).

Allied to *I. alexis* ♀ of S. India and Ceylon, but differing in the smaller crescents on the primaries, the much less lilacine tint of the under surface, and the much more defined white stripe across the secondaries.

XLVII.—*On some new Siliceous Sponges collected by M. Pechuël-Lösche in the Congo.* By Dr. William Marshall*.

[Plate XV.]

Exceptional forms of animals and plants deviating in some respect or other from the general rule have ever excited

* Translated from a separate copy of the Memoir sent by the author to H. J. Carter, F.R.S. The original appeared in the 'Zeitschrift für Naturwissenschaften,' Neue Folge, Band ix. pp. 553–577.

special interest among naturalists. The extraordinary is always adapted to impress us particularly, and especially the extraordinary in the organic world: to the many mysteries which every creature hides within itself we have here added a new one, which asks us how does this particular creature come to differ so completely from the ordinary pattern? what were the constraining causes of this, and how is it modified by them in its whole organization? Parasitism and subterranean mode of life lead to such aberrant phenomena, as also the adaptation of terrestrial forms to an aquatic life, and *vice versâ*; those organisms especially which, belonging to a group otherwise exclusively inhabiting fresh or salt water, have emancipated themselves from this general rule of life of their relatives, and taken up their abode in the sea or fresh water in opposition to it, have always attracted and still attract particular attention. Ten new marine Medusæ could not have caused so much stir as *Limnocodium palustre* alone!

In this way also it comes to pass that much attention has for a long time been paid to the freshwater sponges, and that even small contributions to the knowledge of these remarkable organisms may expect to meet with more consideration and a more favourable reception than, for example, the description of a number of new Ascones or Renieræ. This conviction encouraged me in the following paper to make known some new freshwater sponges, which may perhaps also lay claim to a special interest on the ground of their origin.

General Part.

Before passing to the special descriptions I may be permitted to premise some remarks of a more general nature, in which I shall confine myself to a historical introduction, as it is my intention to revert to the subject in a memoir of wider extent upon the freshwater sponges.

No zoologist of the present day can doubt that our freshwater sponges are derived from marine forms, and that they are the descendants of the latter modified by their mode of life. We have therefore only to ascertain what are the relationships of the freshwater sponges to one another and to the marine sponges, and how far they are altered by residence in fresh water.

Most investigators of our objects seem tacitly to be of opinion that all non-marine siliceous sponges are nearly allied, at any rate more nearly than to marine sponges; and that they form a well-characterized group, the members of which have originated directly from each other, and these *from a common marine form*. This is possible, but certainly not more!

It is just as possible that in the freshwater sponges there

are several series of forms which may be derived from different although perhaps nearly allied marine ancestors, the peculiar resemblances of which would then be rather apparent and acquired by similar adaptations, and consequently resting on analogy, but not inherited in common, and consequently homologous; in other words, that *the freshwater sponges had not a monophyletic, but a polyphyletic origin.* It seems to me worth while to dwell for a moment upon this consideration, and to weigh the *pro* and *contra* of these two possibilities. Although at the outset I see clearly enough that at present no definitive settlement of the question with demonstrative force can be arrived at, and that perhaps such a settlement never will be attained, this shall not prevent me from placing side by side with the current hypothesis (for the assumption of a monophyletic family of "Potamospongiæ" is no more than this), another one which perhaps may be no better, but is certainly not worse.

If we ask, in the first place, in what do the different siliceous sponges of the freshwater agree? the answer is, in three points:—first, they are Monactinellids; secondly, they inhabit the fresh water; and thirdly, most of them, besides sexual reproduction, present an asexual reproduction by means of special buds (*gemmulæ*, *sphærulæ*, *statoblasts*, &c.) provided with a more or less developed siliceous armature, which are developed at certain seasons at the expense of the parent animal, and are usually associated with the decay of the latter.

The first two points are wholly irrelevant in judging of the relationships of the so-called *Spongillæ*; as a matter of course these are certainly more nearly allied to a *Vioa* or similarly aberrant Monactinellid (always supposing that these are themselves really of monophyletic origin, which, from my observations, I have good cause to doubt) than to a Tetractinellid or Hexactinellid; but for the recognition of the phylogenetic relations of the individual species to each other and to the legions of marine Monactinellidæ (which, so far as we can see at present, form at least 75 per cent. of the living siliceous sponges), we do not gain much from them. The second point, the residence in fresh water, will hardly be seriously regarded by any one as coming into the balance; from this we can only conclude that there are sponges, as well as numerous other inhabitants of salt water, which are able to adapt themselves in this particular *. There remains therefore only the

* See the valuable memoir by E. von Martens in the 'Archiv für Naturgeschichte,' 1857, p. 149, in which, however, no consideration is given to the sponges, which indeed at that time were not universally admitted to be animals. See also Semper, 'Existenzbedingungen,' pp. 180 281, ii. 125.

third point, viz. the production of gemmules, that can be regarded as a fundamental criterion of a sponge belonging to the group of the Spongillina of Carter, as indeed is done by Carter * when he characterizes the group thus:—"Bearing seed-like reproductive organs called 'statoblasts.'" According to this the species of the genus *Lubomirskia* from Lake Baikal would be at once excluded, for, according to Dybowski's † positive assertion, they have no gemmules.

But are these gemmules of the other freshwater sponges really so eminently characteristic that they alone are capable of demonstrating the relationship of those sponges? or may they not make their appearance as new formations *sui generis* in originally different forms—that is to say, in forms of different origin? This is open to discussion.

Besides sexual reproduction an asexual process seems to be rather widely diffused among sponges. Leaving out of consideration the gemmule-formation in freshwater sponges, it has been observed in Gummineæ (*Halisarca*, F. E. Schulze), Monactinellidæ (*Rinalda*?, Mereschkowsky), Tetractinellidæ (Tethyadæ, Deszö, Selenka, Perceval Wright), and very probably in Hexactinellidæ; at least the young individuals observed by Carter ‡ on the lateral tufts of spicules of adult *Rossellæ* seem to me to belong to this category of buds, as indeed the above-mentioned naturalist himself remarks, "It seems probable, if these [several minute specimens] do not originate in ova which have respectively fixed themselves there for development, *that they arise from pullulation or budding*." I am now even inclined to interpret as buds the young forms discovered by me in the body-cavities of a specimen of *Hyalonema Sieboldi*, and previously described as embryos §.

According to Selenka ‖ each bud in *Tethya maza* consists of at least from five hundred to one thousand mesodermic cells, and it is his opinion that in the Tethyadæ asexual and sexual reproduction are mutually exclusive; in *Tetilla radiata* from Rio de Janeiro he found during the winter months, from June to August, no ova in course of segmentation along with the buds. I have myself repeatedly examined *Tethyæ* in the budding state, both living (at Corfu) and very well preserved, and especially a number from the Tonga archipelago were of

* Ann. & Mag. Nat. Hist. February 1881, p. 88.

† "Studien über d. Spong. d. russ. Reichs," Mém. Acad. St. Pétersb. sér. 7, tome xxvii. no. 6, p. 11.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xv. p. 118 (1875).

§ Zeitschr. f. wiss. Zool. Band xxv. Supp. p. 216.

‖ Zeitschr. f. wiss. Zool. Band xxxiii. p. 473.

great interest to me. These were of two different sizes; some were on the average about 3 centim. in diameter, the others only 1 centim.; in other respects they had exactly similar skeletal elements and exactly the same structure. In this indeed there was nothing surprising; one could simply regard the smaller specimens as younger; but there was one phenomenon that could not easily be brought into agreement with this view—the larger specimens, so far as they were investigated, showed no sexual products (ova) in the mesoderm, but were nearly all engaged in budding in different degrees; the smaller ones, on the contrary, without exception had ova, but never buds. In presence of these facts one could imagine two possibilities—the sponge in question might propagate sexually when young, perhaps during the summer, but asexually when older and in the winter; or we might have to do here with an alternation of generations, in that from the ova of a sexual smaller form an asexual larger one was developed, from which again the first sexual generation would bud.

With these buds of the marine sponges the gemmules of the freshwater sponges may very well be compared; both occur in addition to the sexual products and separated from them in point of time; both are primarily parts of the mesoderm, which, however, in the sea-sponges when separated pass naked to the surface and immediately commence an independent existence, apparently without any permanent injury to the parent animal; while in the freshwater sponges they become encapsuled, and for a time pass a latent existence in the interior of the dead parent individual. These are certainly noteworthy distinctions, but still not so very difficult to understand; we need only bear in mind that we have to do here with freshwater animals, and that the conditions of existence are essentially different for these and for marine animals. The latter have to suffer very little or not at all under periodically recurrent persistent want of food, their existence is not threatened for a time by the cold of winter or the drought of summer, their conditions of life remain from month to month, in one season of the year as in another, nearly the same, or vary too little to superinduce profound changes in the economy of these marine organisms. Matters are quite otherwise with the creatures dwelling in fresh water, which in this respect rather resemble inhabitants of the land than of the sea.

Some of them belonging to the faunas of warm countries are exposed during the hot season to the drying-up of the element in which they reside; and although this only takes place partially on the banks and here and there elsewhere, it suffices, especially in the case of adherent animals, to pro-

duce in them a sort of summer sleep, necessary for the maintenance of the species, which they pass either by the whole organism being in a state of latent vitality, or by breaking up into descendants (in the form of fragments of themselves).

What the desiccating heat of the sun is capable of doing in warm regions is effected in colder ones by the severity of winter; in both cases the animals are deprived of a part, and, indeed, a principal part, of their conditions of existence, food and moisture or heat, and in the two cases a similar result originates from partly antagonistic causes—side by side with the summer sleep of the tropical or subtropical organisms we get, as is so frequent, a winter sleep of those inhabiting colder zones.

The freshwater sponges, as is well known, do not fall in their entirety during the summer or winter sleep into a latent state of existence; this mode of persistence is perhaps conceivable only in forms living at very great depths, which are but little exposed to desiccation or to the action of cold. As whole organisms they for the most part disappear, and as they partially break up into germinal fragments, their modified seasonal sleep leads to a form of reproduction.

These germinal fragments, if they remained naked as when they are formed, would soon succumb to the power of the heat or cold. What had been acquired for the maintenance and increase of the species would be but badly preserved if from the first there had not also been acquired suitable defensive arrangements against these climatic influences, in the shape of shells which, in this respect quite analogous to the shells of eggs, could protect the germ as much as possible from freezing or desiccation, in short from destruction. Of such protected winter-eggs and winter-germs many occur, as is well known; and it would be interesting to know whether, in double-brooded insects for example, one brood of which passes the winter in the egg (there seem not to be many of them), these winter-eggs differ from the summer-eggs in the thickness of the shell, the mode of sheltering on the part of the mother, &c.; in other words, whether there is a seasonal dimorphism of the eggs. Unfortunately I have been unable to find any statements upon these points in literature; but Werneburg * says of the shells of the eggs of Lepidoptera in general that they differ in relative thickness and "are strongest in those which lie uncovered, and among these are particularly strong in those which remain undeveloped through the winter. Thus, for example, the eggs of *Bombyx neustria*, which re-

* 'Der Schmetterling und sein Leben:' Berlin, 1875, p. 46.

main uncovered through the winter, have harder shells than those of *Bomb. dispar*, which are clothed with a hairy covering."

There is nothing with which the gemmules of the *Spongillæ* can be better compared than with the statoblasts of the freshwater Bryozoa; and this comparison holds good and has been carried out * in every particular. Both are acquired under the same circumstances; both are portions of the main organism separated for the purpose of asexual reproduction; and they agree so closely, even in detail, in their structure, that Carter finds the only difference between them in their size and form. The statoblasts of the Bryozoa indeed have no armature of siliceous spicules, but yet their shells often possess peculiar contrivances which practically represent these in function. It is a fact of particular interest that, just as there are freshwater sponges without gemmules, there are also freshwater Bryozoa, not indeed without statoblasts, but with very slightly developed ones. The sponges in question are the *Lubomirskiæ*, which undoubtedly are perennial, like the marine sponges; some of them, indeed, attain great dimensions (they occur as much as 60 centim. in height), and it is not very probable that such a growth, not bound to an incrustable support, such as the twig of a plant, can take place in the course of a *single* summer. I know very well that *Spongilla*-stocks of considerable size are occasionally referred to, but the statements relating to them are not remarkable for accuracy; we are not informed whether these large specimens grew freely or whether they coated a branch, which, however, makes a very important difference; whether they were in full life throughout, or whether these giants were not perhaps an accumulation of different years, of which only the outermost part was still living. Moreover perennial individuals which in consequence grow to a considerable size are by no means inconceivable in suitable localities, and in these the formation of gemmules might then cease, or indeed, under certain circumstances, need never be acquired, as is the case in the *Lubomirskiæ*. These stand in the same relation to the other freshwater sponges as *Fredericella sultana* to the other Bryozoa of the fresh waters; the latter, according to W. Houghton †, is perennial, and certainly the small development of the statoblasts of this very species demonstrated by Allman is due to this circumstance.

* F. J. F. Meyen in Müller's Archiv f. Anat. und Physiol. 1839, p. 83; H. J. Carter, "On the Identity of the Seed-like Body of *Spongilla* with the Winter-egg of Bryozoa," in Ann. & Mag. Nat. Hist. ser. 3, vol. iii. p. 339 (1859).

† Ann. & Mag. Nat. Hist. ser. 3, vol. vi. p. 389.

This much is certain. The formation of capsuled winter-germs is by no means an exclusive peculiarity of the fresh-water sponges, in which it does not even universally occur; it occurs in exactly the same manner in such very different animals as the Bryozoa, to say nothing of other analogous cases. But if so close a similarity is possible between the statoblasts of the latter and the gemmules of the former, are these gemmules really of decisive significance in the settlement of the question of the relationships of the freshwater sponges? Hardly; any more than the development of uticating organs can be decisive in judging of the relationships of the lower aquatic animals. What Bryozoa and sponges could acquire independently of each other, members of one and the same order can acquire *sui generis*, without any direct relationship between them being thereby demonstrated.

If, then, the different freshwater sponges agree in the structure of the skeleton, not only among themselves, but also in general with the majority of the marine siliceous sponges; if, further, as any one will admit, their common occurrence in fresh water is, according to all analogy, of no value whatever in the elucidation of their relationships; and, finally, if structures perfectly analogous with the gemmules can be acquired by similar adaptation by such perfectly different animals as Bryozoa, upon what is the assumption of a monophyletic origin for the so-called *Spongillæ* really based? This seems to me a question that may well be raised. It will justly be required of me that I should give the reasons that lead me to ascribe a polyphyletic origin to the freshwater sponges: these are their differences of form, their local distribution, and further also the conditions of derivation which must necessarily be assumed for other freshwater animals, notwithstanding their great similarity.

An artificial system will divide the freshwater sponges first of all into two great groups—those without and those with gemmules. In our consideration we shall also for the present accept these groups, although, as I will at once point out expressly, they cannot at all be regarded as natural and as expressing the true affinities.

The first group breaks up into the *Lubomirskiæ* and the *Potamolepides*, to the latter of which belong the new species hereafter to be described and probably also the genus *Uruguaya*, Carter. As regards the *Lubomirskiæ*, these may be the youngest of freshwater sponges which still come remarkably near to certain marine sponges; close to them, and especially to *L. papyracea*, Dybowskyi, comes my *Potamolepis Leibnitziæ*; but probably no one will venture to assert that these sponges are directly

related to one another—the two are just very similarly modified descendants of different nearly allied marine siliceous sponges. One of them belongs to the comparatively modern relict-fauna of Lake Baikal, in which it dwells together with a whole series of inferior marine animals, and even seals; the other has wandered into the Congo, where it occurs together with very remarkable still undescribed bivalves of *Chama*-like habit, which adhere by one shell, and have a black epidermis as in the Najades.

*Uruguaya** seems to be very nearly allied to *Potamolepis* in habit, and especially to the second species, *P. Pechuëlii*; and I would have named the group after this genus, if it had not a name so awkwardly geographical. A direct genetic connexion between these West-African and South-American forms may certainly be regarded as out of the question, for the relations and similarities between the Ethiopic and Neotropical faunas, multifarious as they are, are either due to analogies, or date back to a time when direct communication between the Congo and the Uruguay river by means of fresh water will hardly have existed †.

The other, very probably older, freshwater sponges have a common character in the gemmules—a character which I indeed, as already indicated, regard as of subordinate importance, but which, nevertheless, is serviceable for characterization in an artificial system. This second group again consists of two subgroups, the Parmulinæ and the true Spongillæ, which are remarkably distinguished from each other in their general habit. The former are eminently rigid, and in other respects also, especially in the gemmules themselves, present important peculiarities; they are neotropical and distributed especially in the Amazon and its affluents.

The second subgroup, that of the Spongillæ, is circumpolar, Palæarctic, Nearctic, Indian, and Ethiopic, with forms pushed forward, on the one hand, to the Amazon (*Sp. navicella*, *Meyenia gregaria*, and the species of the genus *Tubella*, Carter); and, on the other ‡, to the Mauritius (*Sp. Carteri*), and even, which is very remarkable, as far as Australia (*Meyenia Capewelli*, Cart.), and consequently is nearly cosmopolitan. For these forms a direct genetic connexion may be possible, but not more probable than spontaneous formation. In the structure

* A genus established, but only as provisional, by Carter, Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 190.

† See A. R. Wallace, 'Geographical Distribution of Animals,' vol. ii. p. 81.

‡ See Carter's memoir in Ann. & Mag. Nat. Hist. ser. 5, vol. vii. pp. 77 *et seqq.*

of their gemmules the *Spongillæ* show peculiar and very significant differences. Some of them (*Sp. lacustris* &c.) are adapted for swimming; others (*Sp. Carteri*, *nitens*, &c.) for swimming and passive movement; others, again, are essentially heavier (*Meyenia*); but all can easily get from one locality to another by the well-known means of transport of the lower aquatic organisms, namely birds*.

The occurrence of *Sp. Carteri* (which has hydro- and aerostatically adapted gemmules, and was previously known only from India, although possessing allies in Africa, namely *Sp. nitens* from the White Nile in the Leipzig Museum) in the Mauritius† is very remarkable, although that island lies in the south-east trade-wind belt and in the southerly diverging branch of the trade-drift flowing from east to west; but we see that the Mauritius, besides some autochthonous forms, possesses a very remarkable mixed fauna, in which Ethiopic and Oriental, and even some Australian, elements meet together.

These considerations may, in a certain sense, be compared with those which Huxley‡ has put forward as to the origin and derivations of the freshwater Crayfish. The great biologist shows that there are two families, well characterized by certain peculiarities, of such Crustaceans, one of which, that of the Potamobiidæ, inhabits the northern, and the other, the Parastacidæ, the southern hemisphere. He supposes that both families descend from a widely distributed primitive form, living in the sea, which he names *Protastacus*, and which has wandered into the fresh waters, and here become differentiated into the ancestor of the Potamobiidæ in the northern parts of the earth, and of the Parastacidæ in the southern; and hence that the river Crayfish, notwithstanding their differences, are of monophyletic origin §.

It is, however, in my opinion, very possible that this hypothetical *Protastacus*, while still an inhabitant of the sea, may have existed under two, three, or even more different forms, local races, or whatever they may be called, and that these, after passing into a different medium of existence, still further adapted themselves to the latter. For a whole series of other organisms of the freshwater, the geographical distribution of which would otherwise be quite unintelligible (such as

* I reserve these various modifications of the gemmules and their probable causes for treatment in a subsequent memoir.

† According to a kind epistolary communication from Mr. Carter.

‡ Proc. Zool. Soc. Lond. 1878, p. 752.

§ See also Jhering, "Die Thierwelt der Alpenseen und ihre Bedeutung für die Frage nach der Entstehung der Arten, in Nord und Süd," Band x. p. 242 (1879).

the crocodiles, many fishes, &c.), we must have recourse to similar ancestors which have lived in the sea.

For the explanation of the origin of the freshwater sponges the conditions, I believe, are much more favourable: here we have in truth still living sea-inhabiting forms which perfectly agree, except for a few, small, and easily intelligible differences, with the former, as shall be immediately shown; in this case we have no occasion to reconstruct an ancestral form, which always has something doubtful about it.

In seeking for forms of marine sponges which might be the ancestors of the freshwater sponges, we must at once leave out of consideration the Hexactinellidæ, Lithistidæ, and Tetractinellidæ, less perhaps on account of the form of their skeletal elements than of their occurrence in deeper water; and of the Monactinellidæ which remain, the *Renieræ* press, as it were, of themselves into the first line. There can be no doubt that these sponges are at present engaged very actively in adaptation. In them we have a group in which, notwithstanding strong differentiation, the individual forms are most multifariously bound together; the struggle for existence will not long be fought between them in so high a degree, through which only in course of time, under fundamentally altered conditions of existence, it will come to pass that the surviving members of the group, like the mountain-tops of a sunken land protruding as islands from a flood, as sharply-defined species will represent well-characterized genera. Renieræ are distributed in all seas, from the tropics to Greenland and Kerguelen's Land; they occur (*Pellina profunditatis*, O. Schm.) from a depth of 324 fathoms*, upwards, as far as existence is still possible for truly aquatic animals. Of *Reniera caruncula* of the English coast, Norman† says: "On rocks between tide-marks. This is one of the regular tide-mark sponges." On the rocky coast of Enoshima, Döderlein‡ found *Renieræ* in places which at low tide were just sprinkled with water; the Mediterranean *Reniera littoralis*§ also descends only a few feet below the surface of the water, and *R. luxurians* is even frequently left dry by the ebb‖. At the same time these sponges are always abundant, not only in individuals, but also in species; in the northern Adriatic over a dozen occur, and near Naples they form more than 24 per cent. of the existing Monactinellidæ (fourteen out of fifty-

* Schmidt, Spongien-Fauna des atlant. Gebietes, p. 42.

† Bowerbank's 'British Sponges,' vol. iv. suppl., ed. by A. M. Norman, p. 81.

‡ Archiv f. Naturg. 1883, p. 111.

§ C. Keller, Zeitsch. f. wiss. Zool. Bd. xxx. p. 580.

‖ Schmidt, Spongien des adriat. Meeres, p. 12.

eight*). They are the sponges which persist longest in relict-faunas, and can adapt themselves to new forms; thus the Caspian Sea still harbours a true *Amorphina* and three other Renierid species of a local genus, *Metschnikowia*, and these four are the only sponges of that great inland sea†. The *Renieræ* are almost the only Fibrospongiæ that can thrive in aquaria.

These polytropic organisms are able to bear with ease diminution of the amount of salt in the water, "as, indeed, in general the genus *Reniera* appears to be especially assigned to the lagoons and brackish water" ‡. Thus O. Schmidt found the brackish bay of Argostoli, in Cephalonia, occupied by incredible numbers of various *Renieræ*; the Monactinellid fauna of Venice consists of more than 57 per cent. (four out of seven) of *Renieræ*, and one of them (*R. luxurians*) also occurs in canals where no other sponges grow, on walls immediately below the surface of the water§.

The *Lubomirskiæ* themselves, although they inhabit fresh water, come much nearer to the true *Renieræ* than to the *Spongillæ*, so near, indeed, that Miclucho‖ at one time did not hesitate to unite them with other forms of his true Renierid genus *Velupsa* (*polymorpha*) as an eleventh variety, *baicalensis*. In them the trains of spicules are cemented together by more strongly developed horny substance than in the *Spongillæ*, their oscula appear stellate, and gemmules or analogous structures are wanting. The cause of these differences may be, that in Lake Baikal (in which, moreover, a *Spongilla* occurs, having probably migrated back, as in the Gulf of Finland¶) the conditions of existence do not compel the sponges to be annual and to form gemmules; or it may also be that, since the *Lubomirskiæ*, as true *Renieræ*, were separated from their marine relatives by upheaval of the land, time enough has not elapsed for the acquisition of new peculiarities.

There is an important distinction in the fact that these sponges are, so to speak, passive inhabitants of the fresh water, separated by force from their relatives, while all the other

* According to Vosmaer, "Voorloop. Berigt omtrent het onderzoek" &c., 20 Nov. 1880–20 Feb. 1881, 6 pages, separately paged (? separate memoir, or reprint).

† There is a memoir by W. Czerniavsky upon the sponges of the Black and Caspian seas; but as it is written in Russian it does not exist for me.

‡ Schmidt, Spongien des adriat. Meeres, p. 73.

§ Schmidt, *loc. cit.* p. 76.

‖ Mém. Acad. Imp. Sci. St. Pétersb. sér. 7, tome xv. no. 3, p. 8.

¶ Dybowski, Mém. Acad. Imp. Sci. St. Pétersb. sér. 7, tome xxvii. no. 6, p. 66.

freshwater sponges probably quitted the sea gradually and voluntarily, and have adapted themselves in the course of a very long time; for, to say nothing of the Diluvium, sponge-spicules have been detected even in freshwater deposits of the Upper Jura*, the formation of which is long anterior to the origin of Lake Baikal.

All these facts certainly prove the remarkable pliability and adaptability which are possessed beyond all other sponges by the *Renieræ*, and these properties will very probably be the same all over the world. Under such circumstances, especially if we also bring in the structure of the freshwater sponges for comparison with the *Renieræ*, there is nothing more natural than to imagine that the former have originated from the latter, *but independently of each other in different parts of the earth, and with the appearance of similar modifications in structure and vital phenomena induced everywhere by adaptation*†.

A part of these modifications are new acquisitions (*e. g.* gemmules), and therefore to a certain extent of positive nature; others, however, are of negative nature, and relate to the disappearance of peculiarities of the marine *Renieræ*, especially to the loss of colour. Most of the *Renieræ* occurring freely and at the surface are intensely and often even very intensely coloured (orange, red, velvet-black, &c.); and I have no hesitation about regarding these colours (as I have already done‡) as alarming or warning agents which deter other animals, not from eating the *Renieræ*, for they are not generally fit for food, but from injuring them in their existence by fruitless attempts to eat them. Now we know that retrogressions,

* Young, Geol. Mag. 1878, p. 220.

† How great, indeed, the power of adaptation is in the freshwater sponges is strikingly proved by the interesting discovery of Dr. Joseph (59 S., B. d. schles. Ges. f. vaterl. Cultur im Jahre 1881, p. 253), who found in the Grotto of Gurk in Carniolia, an absolutely *transparent* (!) form of *Spongilla* (*Sp. stygia*, n. sp.). As I supposed that this freshwater sponge, which will find itself all the year round under the same, or nearly the same, conditions of existence, would form no gemmules, as these would be superfluous, I applied by letter to Dr. Joseph, who forwarded some preparations to me, and at the same time kindly wrote, among other things, as follows:—"Your supposition that no formation of gemmules takes place is correct, for *neither in September nor in April did I find any.*" Some people may perhaps think that the *Spongillæ* of the Grotto of Gurk were not descended from ordinary *Spongillæ*, but directly from Monactinellidæ of salt water, perhaps at a time when the waves of the Tertiary sea eroded the grottos of Carniolia and Friuli. This would have much less probability than the supposition that in consequence of uniform conditions of existence, not dependent upon the seasons, retrogression as regards the gemmules has occurred in *Spongilla stygia*.

‡ Zeitschr. f. wiss. Zool. Bd. xxxvii. p. 245.

which, if we may so speak, are to be accounted for by a tendency to saving in Nature, scarcely occur more strikingly than with respect to offensive and defensive colours. These disappear immediately when the pressing necessity which called them forth is got rid of; and it would seem that the enemies by which *Renieræ* in sea-water might certainly be threatened and disturbed did not migrate after them into the fresh water, and there the varied coloration disappears, just as in the *Renieræ* which live concealed under stones &c. That green *Spongillæ* occasionally occur is due, as is well known, to a symbiotic process, and is no integral property of those sponges.

Although the conviction of the connexion of the freshwater sponges with the *Renieræ* has never, so far as I know, been developed in detail in zoological literature, I have repeatedly supported it, especially in conversation with scientific friends, and Claus gives expression to it in his text-book *. Other naturalists indeed seem to be of a different opinion, such as Keller †, who regards the *Spongillæ* as well as the *Esperiæ* as groups quite distinct from the *Renieræ*; and Carter ‡, who occupies the same standpoint in 1881 as in 1875; and although he places his "Potamospongida" in the same order (Holorhaphidota) with the Renieridæ, separates the latter as his first from the former as his fifth family, by the Suberitidæ, Pachytragidæ, and Pachastrellidæ (*i. e.* by the whole of the Tetractinellidæ, including the Lithistidæ), or, in other words, at least if his system is to be taken as expressing his ideas of the relationships, the relations of affinity between the freshwater sponges and the Renieridæ are but slight, at any rate slighter than those of the two groups with the Geodia for example.

Against my hypothesis of the polyphyletic origin of the freshwater sponges evidence from facts can hardly be brought forward; and although I cannot prove it, it seemed to me not without interest to bring this question under discussion. I may here, however, expressly state that it is not and cannot be at all my design to break up the group of the freshwater sponges; even from considerations of convenience it is desirable to adopt a Renierid group of "Potamospongiæ."

* Grundzüge der Zoologie, 3 Aufl. 1876, p. 194.

† "Upon the latter point the less weight can be laid, as a similar structure occurs *in quite different groups* (*Spongilla, Esperia*)." Zeitschr. f. wiss. Zool. Bd. xxx. p. 564.

‡ Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 85.

Special Part.

POTAMOLEPIS, n. gen.

Monactinellid siliceous sponges of the fresh water of great brittleness, with curved, obtuse, smooth spicules, which (when dry) are closely cemented together by a small quantity of organic substance. No gemmules [statoblasts].

1. *Potamolepis Leubnitziæ*, n. sp.

Forming crusts of 1–1·5 millim. thick, finely porous, of yellowish-white colour and silky lustre, exactly of the appearance of very under-baked wafers. The surface presents a few crateriform elevations of 0·25–0·40 millim. in height, standing in not very distinct rows upon faint undulations, which divide dichotomously in both directions, and frequently disappear, and in which a certain parallelism is unmistakable. At the summit of each elevation there is an osculum of irregular elongate ovate (length to breadth as 1 to 0·5 millim.) and sometimes elongate triangular or pentagonal form, separated from each other by from 1 to 4 millim., but usually by 2 millim. The mouths, which are usually furnished not with smooth but with finely-notched margins, lead into very shallow (0·5 millim. deep) gastric spaces, which immediately break up into several canals; in the angular mouths the opening of a canal of this kind is in general placed in each angle. The canals run horizontally, branch dichotomously, and communicate frequently with the canal-systems of neighbouring oscula. The very numerous and closely-placed incurrent apertures are round and about 0·1 millim. in diameter; between them are situated many much finer apertures, which, in the fresh state, are probably covered by ectoderm.

The three specimens before me formed a thin crust coating flat fragments of stone. Many parts of the latter, especially where other animals (apparently dipterous larvæ forming adherent cases of sand) had seated themselves, were not overgrown.

2. *Potamolepis chartaria*, n. sp.

Oral cone isolated, with round entire margins 0·5–1 millim. in diameter; incurrent orifices not numerous, 0·1 millim. in breadth. Surface like blotting-paper, with a dermal skeleton composed of very delicate, felted straight acerates attaining a length of 0·08 millim. Colour in the dry state chocolate-brown.

This species much resembles the preceding in habit and the

form of the proper skeleton-spicules, but is well characterized by the round oscula, and especially by the presence of a dermal skeleton. In consequence of the presence of this dermal skeleton the surface of the sponge acquires a peculiar paper-like appearance, and at first I was inclined to regard this coating as consisting of fine dried mud. Microscopic examination, however, soon taught me better. The dermal spicules lie irregularly (tangentially at the incurrent and excurrent apertures) in a tolerably thick crumbly mass of dried substance which cannot be removed, but rather adheres very firmly to the underlying skeletal parts. The colour of the organic substance, especially of that cementing together the proper skeletal elements, is chestnut-brown. It is possible that this colour is to be accounted for by the great amount of iron in the Congo (almost all Africa is exceedingly rich in iron), which colours the surface of the stone as if with black-lead and penetrates several millimetres into it; but in this case it is certainly wonderful that the other sponges found there under precisely similar conditions show no trace of it.

3. *Potamolepis Pechuëlii*, n. sp.

Crust-like, with numerous oscular cones as much as 10 millim. in height, which are so compressed laterally that one diameter of the base is in proportion to the other as 1 to 2. The cones stand in the single specimen in the direction of their longest diameter in indistinct rows, which diverge radiately from one spot on the margin; only quite exceptionally do they stand perpendicularly to the adherent base of the sponge, but most of them ascend with an inclination of 45° in the direction of the greater diameter, and in all the inclined side is turned towards the point from which the rows of cones radiate, while the other side descends steeply. At the summit of each cone there is a mouth-opening (in some which are fused together, two), which is simply round, and may attain a diameter of 3 millim. These oscula lead into simple short gastric spaces (4 millim. deep in the longest cones), and these break up into a gastro-vascular system, which is not further traceable. The spicules present a somewhat slenderer form and somewhat smaller curvature than those of the other two species; they are cemented together by a small quantity of organic substance into coarse trains as much as 1 millim. broad, which, crossing each other irregularly, form a very confused network with meshes of very unequal size (0·5–2 millim.) and quite dissimilar form, in some of which, very probably, there will during life have been at least incurrent apertures. The network is developed in exactly the same

manner upon the mantle of the cones as in the interspaces and in the interior of the sponge. The colour of the dry sponge is ash-grey with a silky lustre, and this and the large size of the meshes give it the appearance of a coarsely porous pumice-stone.

With regard to the conditions under which the *Potamolepides* occur, their discoverer, Dr. Pechuël-Lösche, has given me orally detailed information. The specimens come from above Isangila, a place which is distant from the sea about 150 nautical miles by water, and is situated upon the Congo more than 100 metres above the sea-level. They were also observed near Kalubu, about 50 nautical miles further up the stream. Between the place where they were found and the sea the river forms six falls and rapids—namely, near Yilala, Manguvu, Inga, Nsongo Yilala, Ngoma, and Isangila itself. In the actual bed of the river, on the constantly submerged rocks, they were not observed, which, however, may have been a matter of chance; but the rocks of the inundation-region at the sides were in places thickly covered with them, so that, as the greater part of the sponges are white, this gave the rocks the appearance of being covered with the excrements of the wading birds which are so numerous there, as indeed my honoured friend at first believed to be the case. The most remarkable thing is that these rocks, which, during the high water of the summer, with its rapid flow (of about one German mile per hour), are from 2 to 3 metres under the surface of the water, lie, during the months of June, July, August, and half September, perfectly dry under the scorching heat of an African tropical sun. The sponges were collected in July. These rocks belong to one of the clay-slates striking from south-east to north-west and dipping to the south-west, and are covered with sponges only on their eastern side, which is towards the stream and more or less overhangs it, and here, which is sufficiently important, with all the three species together. Frequently spaces of a square metre are overgrown, but not so that the sponges form a connected coating; they certainly stand close together, but always in distinct colonies not bigger than a plate. On the diabase-rocks which cross the bed of the river near the rapids of Isangila, no *Potamolepides* were found. Their absence from these rocks need not by any means be due to an aversion of the sponges to this rock, and a preference for the clay-slate; at the spots where the diabase-rocks occur, and through them, the conditions of flow of the river will probably be so modified as to prevent any favourable development of the sponge.

In habit the *Potamolepides* show no resemblance to the *Spongillæ*, or indeed to any Renierid, and in their firmness and brittleness they much rather resemble certain Hexactinellidæ, especially *P. Pechuëlii*, which, in the microscopic structure of its skeleton, in the arrangement of its fibres, &c., greatly reminds one of a *Farrea*. I believe these remarkable peculiarities will become intelligible if we consider more closely the conditions under which the *Potamolepides* live. Here it is to be remembered above all that they live in running water, which certainly during the rainy season flows strongly, and will break with violence against the slabs of rock, and that they occur in opposition to the direction of the stream. In the presence of such factors a young sponge will not be able to grow into a branched shrub, or even into a turf-like cushion, in the same way as *Spongilla lacustris* or many *Lubomirskiæ* in still water: the pressure of the flowing water will rather compel it to cover its base of attachment with as thin a crust as possible, by which means a further advantage is gained towards its comfortable maintenance; the water surrounding it may indeed, as a destructive torrent, be rich in suitable nourishment, but it is too rapid in its movements and will leave the detritus contained in it for too short a time in one place to allow the sponge to derive much advantage from it, although indeed the chances may be somewhat more favourable on the overhanging side of a slab of rock than elsewhere in the bed of the river. The sponges take up their nourishment through apertures of the surface: when it is uniformly abundant and easy to obtain, the sponges may be cylindrical or conical, which, according to their ontogeny, seems to be their original form, and they need not adapt themselves to an increased reception of food. Thus in a round sponge, if we assume that the incurrent apertures are, under all circumstances, equally distributed, the proportion of the surface of the body (square) to the contents of the body (cube) suffices to nourish it, that is to maintain it and enable it to increase in size and reproductive products. The conditions are different if the food is scanty or difficult to obtain: then the above approximate proportion of the square to the cube will no longer suffice; the surface must be increased in proportion to the mass of the body, and with this the number of the food-receiving incurrent apertures must be increased. How can this be effected? Sometimes by the formation of pits, folds, intercanalicular spaces, pseudogastres, &c.; but this does not seem to be always admissible: residence on the underside of stones which do not form much of a hollow will put a veto upon it; but especially, as in the present case, very rough

water will not admit of it. The sponge must then seek in some other way to help itself, and this it can do only by forming a thin crust in which a large surface is developed with a small volume of body. This consideration leads to a series of consequences, to which I will here refer only *en passant*. On looking at a large, round, conical or cylindrical sponge with a smooth surface, we can assert, *à priori*, that it is produced under favourable circumstances, and has had not only abundance of food, but also the necessary quiet; another, composed of mæandrically united plates, interwoven branches, &c., and traversed by numerous intercanals, will have had quiet but a more slender diet; but a thin crust, unless it has been mechanically confined in extension by growth between stones, will have passed its life with very little rest and with a badly supplied table; and in the last-named case the sponges are also usually polyzoic with small personal regions. In connexion with this, the facts of individual development are very instructive; all young sponges are rounded, conical, or cylindrical, and, as a matter of course, the only question is, under what conditions they are further developed. By these their form is governed, and many species are in consequence exceedingly polytropic, showing an almost infinite power of form-variation; while others are in so high a degree monotropic that they rather die than make concessions to external circumstances in their form. There are extremely variable, but also extremely constant sponges, and these latter are naturally the rarer ones.

It is clear that the specimen of *P. Pechuëlii*, under somewhat different circumstances, with a less pressure of water, may have been more freely developed than the specimens of the other two species; but the influence of the moving water is unmistakable in the position of the oral cones and their tendency in one direction. Probably also the serial arrangement of the oscula which we recognize in all the species may be referred to the same cause; in *P. Pechuëlii* they lie also in the direction of the strike (direction of the greatest diameter) of the oral cones. In this sponge probably the central persons were not first developed, but those in the margin indicated by *a* in fig. 10. In very strongly moving water a sponge will scarcely be able to bud in all directions; the buds will rather always be formed in one direction, one behind the other, so that the younger will be somewhat protected by the older ones from the disturbing influence of the flowing water; this may lead to a radiate arrangement, for a current of water breaking upon an obstacle opposed to it does not reunite immediately behind it, where there is rather a quiet

spot which, if the obstacle was a ball suspended freely in the water, would have the form of a regular cone, but otherwise may be of various forms according to the configuration and position of the interposed object. In our sponge growing as a crust, the quieter space of water will have been approximately semiconical, at least for a certain distance, until the laterally diverted masses of water united again; and here the oral cones could become better developed than the anterior and older ones, which are more exposed to the force of the water, so that, under certain circumstances, the oldest oral cones will show the poorest development.

It may be objected that the freer development of the oral cones in *P. Pechuëlii* might indeed indicate a somewhat weaker pressure of water, but that the differences in the form and arrangement of the spicules of the different species are in this way by no means explained; for in *P. Pechuëlii* they are more extended and arranged in trains, whereas in the other species they are much more considerably curved and absolutely without any tendency to arrange themselves in bundles, both of which characters appear certainly to indicate growth in quieter water. I believe that this is only apparent; more strongly curved spicules will be able to interlock more closely than less curved or straight ones; they will form more compact masses, and so be able to oppose a more considerable resistance to the force of the currents, which will operate with effect in opposition to the efforts of the latter to arrange the skeletal elements of the sponge, whether they be proper to it or foreign bodies incepted to strengthen it, in trains in its own direction. A sponge with straight spicules under the very strong influence of a current acting in one direction must have a difficult task to maintain itself in position unless its spicules are remarkably spinous, or unless it differentiates auxiliary spicules in the form of hooks &c. In my opinion, to which I have already often given expression, the forms and arrangements of the skeletal elements of the sponges are for the most part to be referred to influences of purely mechanical nature, which, as they will frequently come into conflict with the inherited tendencies which dwell even in these structures, have led to that enormous abundance of often very wonderful adaptations to conditions which are usually, at least directly, still obscure. Besides the movements of the water acting from without, the currents in the interior of the sponge caused by the position of the flagellate chambers and the action of their ciliary organs will also be important factors in the construction of the skeleton; but very frequently also the position and nature of the flagellate cham-

bers will be governed by external influences (quantity of food and also again conditions of current). Experimental investigations in which sponges, and especially the exceedingly polytropic *Renieræ*, are brought under the most various conditions, must, I am firmly convinced, lead to the most astonishing results, and be of immense importance, not only for Spongiology, but also for the whole great theory of transmutation.

From such considerations it seems not unjustifiable to suppose that *P. Pechuëlii* and *P. Leubnitziæ* are forms of the same species which have become differently developed under different circumstances; but so long as no transitions between them are known to us we must regard them as two species.

It only remains now to explain the reasons which have induced me to deny gemmules to the *Potamolepides*. I will lay no stress upon the fact that *P. Leubnitziæ* and *P. chartaria* are too thin and have the spicules too closely interwoven to give room for such structures, as they might easily have acquired other arrangements, such as cavities for their reception; but if we consider that, according to what has gone before, the formation of gemmules in a tropical freshwater sponge is only intelligible during the dry season, while the specimens under consideration were, without exception, collected during the summer months, my view that they form no such germ-fragments receives very essential support. The specimens are so wonderfully preserved, even to the finest marginal parts of the oscula, that there can be no notion of their having died the year before or still earlier, and moreover it would be singular if the whole number of specimens examined were *accidentally* without gemmules. I have *never* found indigenous freshwater sponges *barren* (*i. e.* without products of asexual reproduction) in the autumn and winter, and a very considerable number of them have passed through my hands in the course of fifteen years. It is indeed possible that the non-differentiation of reproductive fragments might be a consequence of the different conditions of existence of the *Potamolepides*; but this seems to me not very probable, and I am more inclined to the opinion that, just like the *Lubomirskiæ*, and probably also *Uruguaya coralloides*, they have adapted themselves to existence in fresh water at a recent date in comparison with the *Spongillæ* and *Meyeniæ*, and that, in case it should become necessary, the formation of gemmules may in course of time occur in them also.

In conclusion, I once more beg all my fellow-labourers to enable me to extend still further my investigations upon freshwater sponges by sending me abundant materials from all possible localities. Only the cooperation of many can bring

us nearer to the solution of certain general questions with regard to these interesting organisms. The greatest importance attaches to remarks appended to the specimens sent as to the time when the sponge was found, and the most exact possible statements (they can hardly be exact enough) as to the conditions of the locality, movement of the water, nature of the ground, amount of lime and salt (if any)—every thing is necessary to be known, for we cannot at all foresee what factors are of real importance in arriving at a conclusion.

EXPLANATION OF PLATE XV.

Potamolepis Leubnitziæ, n. sp.

Fig. 1. Beautifully preserved specimen upon a slab of stone, nat. size. At *x* a colony of cases of larvæ (of Diptera ?).
Fig. 2. Three oral cones, × 4.
Fig. 3. Rubbed specimen, showing partially the course of the gastro-vascular system. × $\frac{3}{2}$.
Fig. 4. Gastric space with ramifications, from the same specimen. × 4.
Fig. 5. Skeletal elements in their natural position. × 30.
Fig. 6. Two isolated spicules. × 100.

Potamolepis chartaria, n. sp.

Fig. 7. Three oral cones.
Fig. 8. Skeletal elements; below are five spicules of the true skeleton, which are covered by a felted web of very fine uniaxial spicules. × 30.
Fig. 9. Four isolated uniaxials of the dermal skeleton. × 120.

Potamolepis Pechuëlii, n. sp.

Fig. 10. Perfect specimen. *a*, oldest part.
Fig. 11. Two spicules.

XLVIII.—*Additions to the Australian* Curculionidæ.—Part X. By Francis P. Pascoe.

Brachyderinæ.

Styreus, n. g.
—— geonomoides.

Leptopinæ.

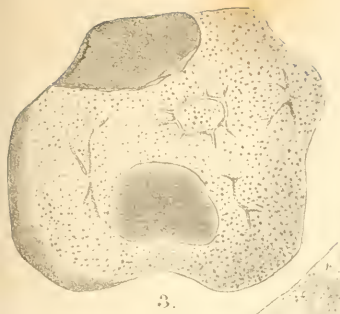
Leptops punctigera.
—— incompta.
—— vermicosa.

Gonipterinæ.

Minia, n. g.
—— opalescens.

Hyperinæ.

Prophæsia florea.

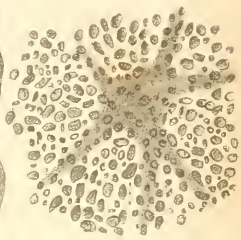


3.

2.

5.

1.



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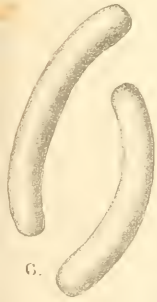
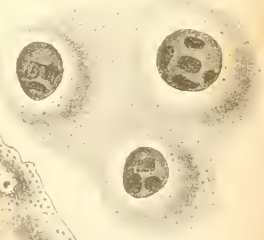


6.

10.



7.

9.

8

11.