nature," and so on; however, this matter is unimportant and need not be dwelt upon.

The points respecting *Delias ithida* and *Terias sari* may be easily settled; the types of both being in the collection of the British Museum, Mr. Distant, who is often able to visit that institution during the year, should neither have trusted my opinion as to the probable locality of the former nor Mr. Moore's identification of the latter. It is no excuse to say, when an error has been committed, "I did but copy the error of my friend;" it certainly reminds one of the ancient inhabitants of Paradise, but not in their happiest condition.

In answering what I thought a sufficiently clear statement respecting *T. senna*, Mr. Distant seems utterly to have missed the point—that the *T. santana* and *T. senna* of Felder are species allied to *T. drona*, or, if he prefers it, are local races of *T. drona*, and have next to nothing in common with *Terias inanata*. My identification of *T. senna* is the same as it always has been, for Mr. Distant himself proves, by reference to my paper of 1871, that I then regarded it as possibly a variety of *T. santana*; he must therefore be mistaken when he says that he examined specimens of *T. inanata* and *T. senna* in the national collection and failed to see any differences, since the most unskilled lepidopterist would see them at a glance.

Lastly, in my note on *T. æsiopæ* I begin by the distinct statement that "For some years past this species has been entirely misunderstood;" therefore what I or any one else regarded as *T. æsiopæ* in 1879 is entirely beside the mark as an excuse for figuring the "true *T. æsiopæ*" under the name of *T. hecabe*. The typical, and therefore "true," *T. æsiopæ* being a Chinese species and not occurring (so far as is known) in any part of India, the locality "Continental India" is not correct. If my statement on this head was of a misrepresentative character, I regret that it was made; but until I read Mr. Distant's explanation I always supposed that this truly "somewhat wide" one was intended to rank with others separated by the same stop, thus:—"Continental India; N.W. Himalaya; Bombay;" &c. I am not aware that I have anywhere remarked that Mr. Distant has figured as *T. æsiopæ* a variety of *T. hecabe*; what I have stated is that he has figured the male *T. æsiopæ* as *T. hecabe*, var. *a*.

The Nerve-terminations in the Pedicellariæ of Echinida, their Sense-organs and Glands. By Dr. OTTO HAMANN.

Nerve-terminations have not hitherto been described in the pedicellariæ of the Echinida, nor indeed elsewhere in their bodies. The only statement as to a supposed sense-organ has been made by Sladen*, who observed upon the inner surface of the three valves of gemmiform pedicellariæ in *Sphærechinus granularis* cushion-like elevations, which have since been seen also by later observers, such as Köhler†. The latter observer says:—"It is possible that these

* Ann. & Mag. Nat. Hist. ser. 5, vol. vi. p. 107 (1880).

† 'Annales du Musée d'Hist. nat. de Marseille,' 1883.

peculiar swellings perform the function of organs of touch; but it is impossible to find any relations between the cells which compose them and nervous elements." I have been able to detect both the nerves and their terminations, and this both by means of serial sections and by observations on the living animal.

The different kinds of pedicellariæ—gemmaform, buccal, tridactyle, and trifoliate—are to be regarded as exquisite sense-organs. But besides this function of sense-organs, they possess the most various other functions, according to their form, size and structure, and their arrangement upon the test, and these may be ascertained by experimental investigations and by careful observation of the mode of life. The investigation of the minute structure must go hand in hand with these.

If we examine the inner surface of the three jaw-pieces of *Strongylocentrotus lividus*, we observe in the base of each jaw-piece a tumuliform convexity, which is covered with rigid setæ. These elevations are sense-organs, which consist chiefly of epithelial sense-cells, as I have already found to be the case and described in Astorida and Holothuriæ. At their free ends these cells bear tactile setæ, while their basal portions are continued into the finest fibrils, which ramify and are connected with the nervous plexus. A branch nerve runs to each tactile elevation, branching off from a larger nerve-stem, which may be traced to the apex of each valve.

I have found the following statements to apply universally to all the various forms of pedicellariæ as regards the ramification and course of the nerves. In the head of each pedicellaria three nerve-stems are distinguishable, running in the interstitia of the three adductors of the valves. Each nerve-stem runs to the apex of the valve in a direct line. Throughout its course branch nerves of various strength are given off on all sides, which pass to the sense-organs, the musculature, and the glandular sacs. In the interstitia of the three muscular bundles (adductors) there issue very fine fibrils intermixed with ganglion-cells, producing a network of nervous threads which enter the musculature.

In *Echinus acutus* there are two tactile elevations (*pedicell. gemmiformes*) on the inside of each valve. One of these is basal, the other is placed just below the hooked calcareous tip. Between these we find a third sense-organ of simple structure, situated about in the centre of the inner surface of the valve. Between these organs sense-cells are scattered through the whole epithelium, as is shown by the nerve-threads passing to them.

In *Strongylocentrotus lividus* there is only one tactile elevation on the inner surface of each valve (*pedicell. gemmiformes*); it is placed basally, while the apex of the valve is covered with sense-cells.

In *Sphærechinus granularis* the sense-organs are limited to three elevations, situated basally on the inner surface, and these again show separate projections upon which tactile setæ arise. These projections are composed of cells, which form an organ reminding one of the gustatory papillæ of the higher animals. These structures are composed of both sense- and supporting cells.

As regards the course of the nerve-stem, the so-called tridactyle

and buccal pedicellariæ show similar characters, but a simpler structure of the sense-organs. The interior epithelium of the valves, which is characterized by an abundance of long cilia, is covered with sense-cells, which, however, do not, as in the above-mentioned cases, collect together to form special sense-organs. While in the *pedicell. gemmiformes* a strong nerve-stem runs to each sense-organ, in these a number of ramifying nerves are present, running to the epithelium. The nerve-stems consist of very fine threads, upon which are seated bipolar and multipolar ganglion-cells. At the bifurcations these are accumulated in great quantities. Even where the nerves consist only of a few fibres, the ganglion-cells may be easily distinguished from the cells of the connective substance, partly by their size and partly by their coloration with the most different fluids. Even the finest nerve-fibres also may be easily recognized among the connective fibres by suitable staining. The latter are stained in a much less degree than the nerve-fibres.

Those pedicellariæ which possess sense-organs, *i. e.* the gemmiform pedicellariæ, are also all furnished with glands, which are seated in the walls of the valves. They discharge their secretion through an aperture situated at the apex of the valve, and indeed above the calcareous hook, or dorsally. The glandular sacs, of which there are one or two in each valve, are of an oval form, and possess a strongly developed musculature, serving for the evacuation of the slimy secretion. The minute structure of the epithelium lining the glandular sacs presents the most various modifications in the different species, but it would be difficult to describe these without figures.

Besides the *pedicell. gemmiformes* I have found glands in pedicellariæ which cannot without difficulty be arranged under any of the above-mentioned four groups, *e. g.* in pedicellariæ situated on the buccal membrane in *Dorocidaris papillata*.

The function of the different pedicellariæ has hitherto been in dispute without the attainment of any agreement, because the presence of sense-organs and glands, and the minute structure in general, has been quite unknown, and only the calcareous pieces have been described. (The only exceptions to this statement are made by Sladen and Föttinger, who detected and described glands in *Sphærechinus granularis*.)

In the first place, the pedicellariæ, whatever their form may be, will function as tactile organs; this is indicated by the numerous nerve-terminations in both the head and the stem.

The smallest forms, such as the *pedicell. trifoliata*, undoubtedly cleanse the test from the smallest particles of sand, Protozoa, and foreign bodies in general, whether these are directly upon the surface of the test or upon the spines. They will also have the function which A. Agassiz has claimed for all forms of pedicellariæ.

The larger kinds, such as the tridactyle pedicellariæ, only rarely serve this purpose—primarily they exist for the purpose of keeping off larger living bodies, such as worms &c., and so act as weapons; but (as I conclude from the transversely striated musculature found only in them) they also serve for attachment to foreign bodies during movement, as has already been established by Romanes and Ewart.

The *pedicell. gemmiformes* have the same function, and in grasping they are assisted by the secretion in the glandular sacs of the valves, as experiment shows. In *Echinus microtuberculatus* the gland-bearing pedicellariæ stand chiefly on the dorsal surface and serve, as I have been able to ascertain from many animals kept in the aquarium, to hold fast fronds of seaweeds &c. with which the sea-urchin masks itself both when at rest and when in motion. In this the slimy secretion of its glandular pedicellariæ is of the greatest service.—*Sitzungsberichte der Jenaischen Gesellschaft für Medicin und Naturwissenschaft*, 1886.

Discovery of the Heart in Gamasus.

To the Editors of the 'Annals and Magazine of Natural History.'

GENTLEMEN,—My attention has just been called to a translation in your February number of Prof. C. Claus's paper in the 'Anzeiger' of the Academy of Vienna relative to Herr Willibald Winkler's supposed discovery of the heart in *Gamasus*. If Prof. Claus and Herr Winkler imagine that the latter has observed this organ for the first time they are in error. It was noticed in 1876 by Dr. P. Kramer, then of Schleusingen, who published his remarks on the subject in the *Archiv für Naturg.* xlii. Jahrg. 1 Bd. p. 65, as one paragraph of a paper entitled "Zur Naturg. einiger Gattungen aus d. Familie d. Gamasiden." The paragraph is as follows:—

"Das Circulationsorgan. Bei *Gamasus* findet sich endlich im letzten Drittel des Hinterleibes ein lebhaft pulsirendes Herz. Da bei den meisten Arten die verhärtete Rückendecke die Beobachtung der innern Organe unmöglich macht, so eignen sich zur Auffindung des Herzens nur unerwachsene oder eben durch eine Häutung gegangene Thiere, an denen es aber leicht und sicher erkannt werden kann. Seine Bewegungen sind von denen der Excretionsdrüse natürlich auf das bestimmteste verschieden, auch entspricht seine Lage ganz dicht unter der Haut der Lage desselben Organs bei andern Gliedertieren."

Dr. Kramer's observation is perfectly well known amongst Acarologists and has been publicly referred to by Dr. Haller, myself, and others in our writings. It will be seen that Dr. Kramer did not describe the valves, and it is perhaps fair to say that in some quarters doubts have been entertained whether the organ really was a heart or whether the movement was not more allied to the strong, presumably peristaltic, movements which may be observed in the cæca of the alimentary canal in young Gamasids. If Herr Winkler's observation of the valves be reliable it will, of course, strongly confirm Dr. Kramer's discovery.

Prof. Claus may possibly not find it so easy to trace the organ in other families of the Acarina, as, judging from his remarks, he may very naturally anticipate; at all events, I am not aware that it has hitherto been traced in any other, although, as above stated, Kramer's observation has been well known for several years.

I am, yours obediently,

ALBERT D. MICHAEL.

Cadogan Mansions, Sloane Square,
April 17, 1886.