Zoology. — *New observations on the feeding of Vampyrella lateritia (Fres.) Leidy.* By H. R. HOOGENRAAD and A. A. DE GROOT. (Communicated by Prof. J. BOEKE.)

(Communicated at the meeting of December 27, 1941.)

(*Rhizopoda* and *Heliozoa* from the freshwater of the Netherlands. IX).

In sphagnum which we gathered on the "Zijpenberg" near Rheden in April 1941 we found in May and June of that year a number of specimens of a *Vampyrella*-species which was most probably *Vampyrella lateritia* (FRES.) LEIDY.

They fed on the contents of the cells of a *Mougeotia*- (= *Mesocarpus*- ?) species. A few times we were able to watch this process closely; as it differed in some points from what was found by the former observers — CIENKOWSKY, PENARD, WEST, CASH, LLOYD, GOBI — and we could moreover compare it with our own observations both on *Vampyrella* and on *Hyalodiscus* and *Difflugia*, we thought it worth while to give a more or less detailed account of our experiences, the more so as the descriptions of the observers mentioned above do not agree with each other in every respect and this species is relatively seldom observed.

The morphology of the animal showed the normal characteristics (Fig. 1). During the rapidly and evenly gliding motion between two feedings the form was of a moderately

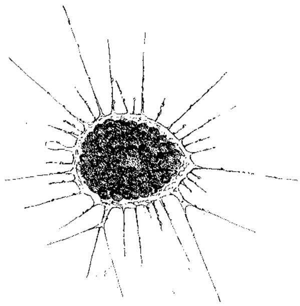

Fig. 1.

flattened spheroid, seen on top a pure circle or a broadened ellipse; this last form was more prominent in specimens that crept forward along the weed-filaments. The size without the pseudopods was from 20—50 μ. Ecto- and endoplasm were distinctly separated; the first formed a narrow, colourless border round the second, which as a rule showed the normal brick-red colour, sometimes with clearly visible green spots inside, caused by the food taken. A few brownish-green specimens were seen, a colour probably caused by the ingesting of the contents of cells with their chromatophores repeatedly and at short intervalls. Sometimes a bright central spot was visible in the thick endoplasm, not sharply separated from the surrounding plasma, probably the place where the nucleus was found. Contractile vacuoles could not be established with certainty, though a number of non-contractile ones could be seen, bulging outside the ectoplasm-border as small bubbles.

The pseudopods, mostly radiating on all sides, appeared in the two forms usually distinguished in this species: the long ones, sometimes three times the diameter of the plasm-body, either branched or not, with distinct grain-movement, and short ones, so-called pinhead-formed, distinctly thickened at the top, disappearing and appearing again and again. The nature of the last is still problematic; in some cases we got the impression that the sudden darting of this pseudopods was not what it seemed to be, but found its cause in reality in the rapid gliding of a granulum along an already existing pseudopodium of the first kind, of which the distal part had escaped our observation. In a single case we saw a pseudopodium, more than 160 μ long, which with a broad basis as a sort of pseudopodium-stalk rose from the plasm-body and ended in two fine threads, which the animal cast as an anchor on the objectglass while it ingested its food (Fig. 1c).

Now at the hand of the figures we shall first give an account of our observations on

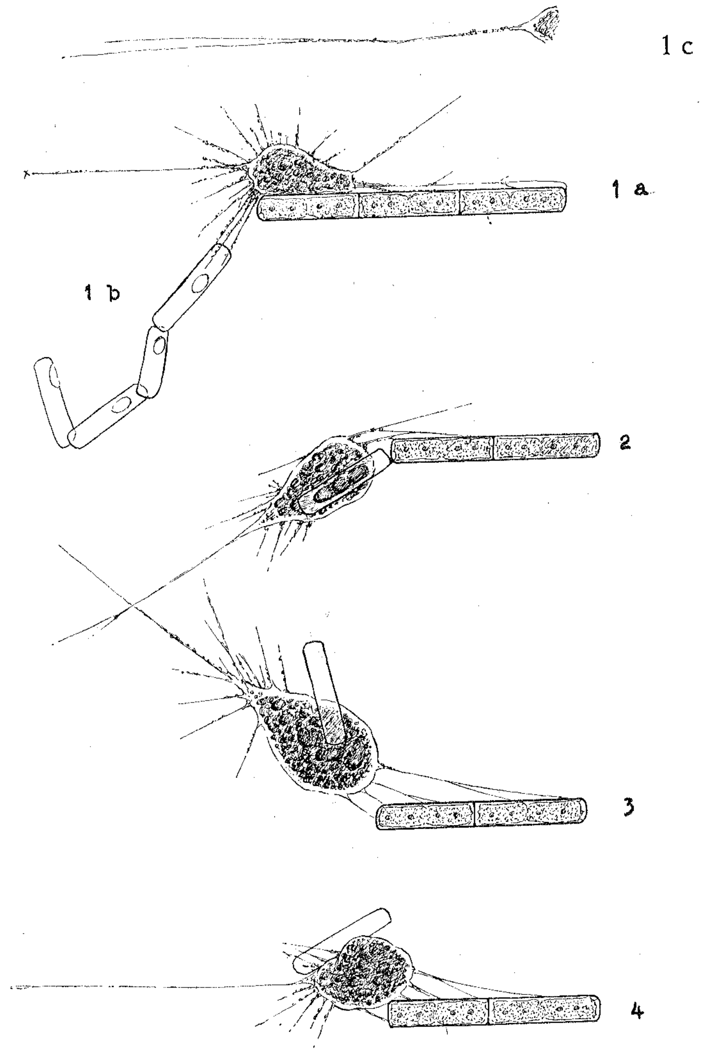

Fig. 1a—4.

the feeding and then shortly relate the experiences of earlier observers and our own (1907 a and b). We repeatedly observed this feeding, which on the whole followed the same lines, and here give the descriptions of two cases which may be considered as typical.

June 1. 9.10 a.m. (Fig. 1a, b). A *Vampyrella*-specimen is seen in contact both with a filament of a *Mougeotia*-species, consisting of three short, living cells, and with a series of four empty cells, connected together, which all showed the typical round hole, through which they had been emptied by a *Vampyrella*-specimen, probably by the same that was on its way to the three-cell-filament, with which it was already in contact. The plasm-body, somewhat long-stretched now, still possesses pseudopods that radiate on all sides; at the side that led the way in moving they were united to a thick bundle, which also

stretched itself on the two following cells, to which these pseudopods attach themselves like "pulling-threads". At the back of the animal is visible the above-mentioned pseudopodium, 160 μ long; this remains there during the whole process of ingestion of the food.

9.15 (Fig. 2). With a sudden shock the cell thus attacked breaks loose from the others, while the animal swings with this cell round the above-mentioned pseudopodium, which acts as an "anchor-cable". The pulling-threads remain in contact with the two other cells; simultaneously with the shock the now isolated cell begins to empty itself rapidly.

9.17 (Fig. 3, 4). The first cell is entirely empty now; the empty cell-wall sticks for some time to the animal. The pulling-threads to cell 2 and 3 are shortening.

9.20 (Fig. 4a). While it continues to shorten the pulling-threads the animal lies down against the following cell; one of these threads clearly embraces the top of cell 3.

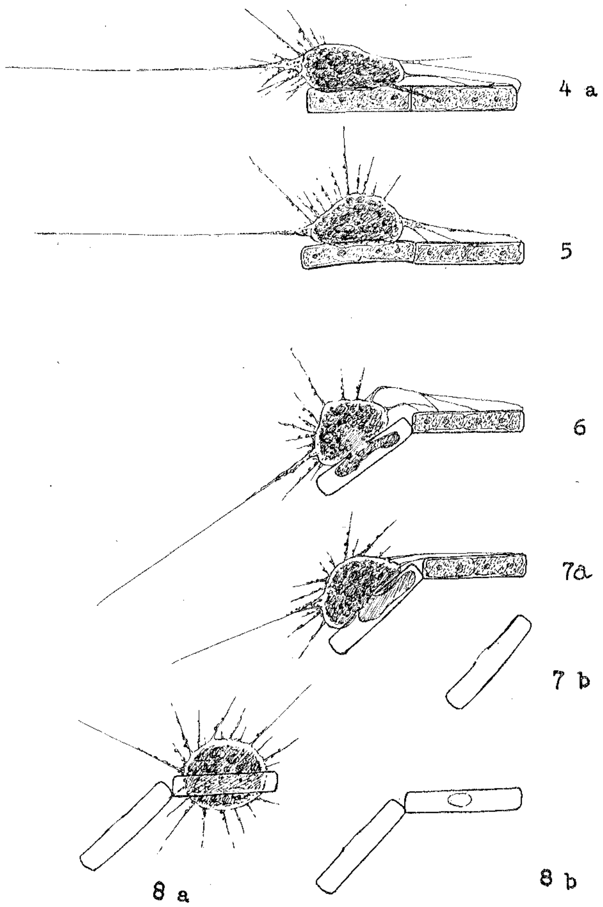

Fig. 4a—8b.

9.25 (Fig. 5). Cell 2 now seized shows a slight bending towards the side of the animal; then this cell too immediately bursts open and its contents disappear into the plasm-body of the animal. This is again accompanied by a shock, which tears the cell loose from the next, number 3, and makes the animal together with the cell attacked swing round the "anchor-cable", that is to say: flings it aside. Both cells (Fig. 6) remain connected with a small part of the cell-walls facing each other, just as was the case with the four empty cells which we saw first. Curved pulling-threads form a bridge between the two cells.

9.27 (Fig. 7a, b). Through the hole made in the cell-wall the animal puts a broad, finger-formed pseudopodium into the lumen of the cell as if to take up the remains of the contents possibly left behind ("to lick the pan clean"). After this the animal passes on to cell 3, which is emptied in the same way in about five minutes. The connection with cell 2 is maintained; the pulling-threads are no longer to be seen now, perhaps because we could only observe the animal from the bottom-side and not sideways as was the case with the two preceding cells.

9.35 (Fig. 8a, b). The last cell is left; the empty cells show the holes in the wall. The holes have an elliptical form and smooth edges without any trace of irregularities or fringes.

June 2. 5.30 p.m. The same specimen of the preceding day is observed while it is emptying a cell of a *Mougeotia*-filament, consisting of five long cells. The two cells following the attacked one are both still intact; after these two more cells follow, which show the typical holes in the wall and have probably already emptied been by the same or by some other specimen.

5.33 (Fig. 9). The animal leaves the final cell now emptied and proceeds to the

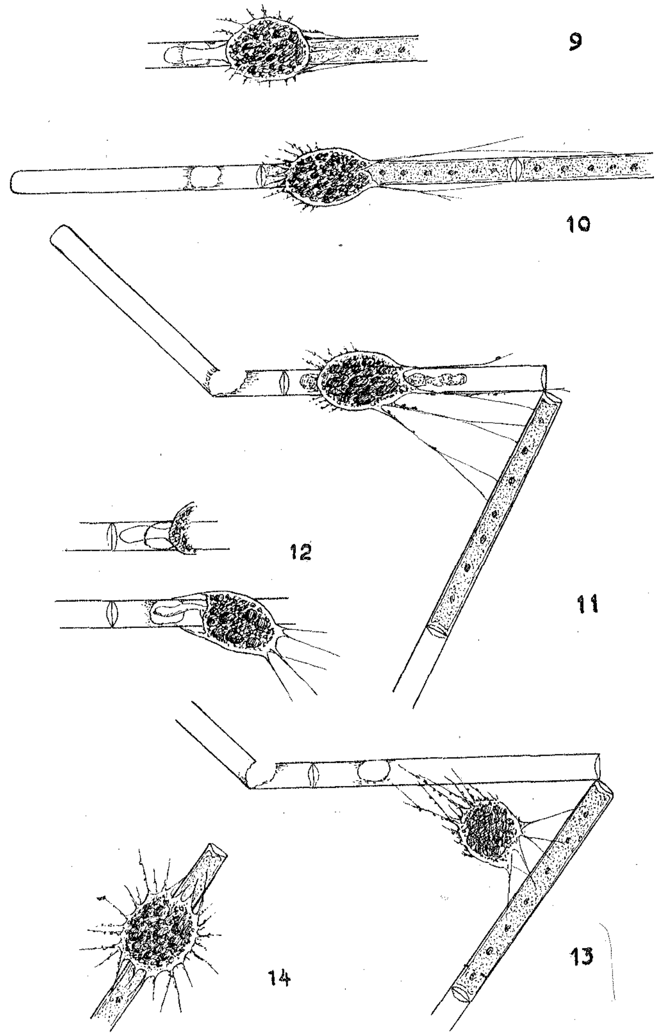

Fig. 9—14.

following. From the hole in the wall of the first cell, a broad, finger-formed pseudopodium is gradually drawn back, which was not visible before the animal moved away from the hole.

5.35 (Fig. 10). The contact with the first cell is totally lost now and the pseudopodium drawn back. Long pulling-threads stretch over the whole length of the second cell and reach as far as the next.

5.38 (Fig. 11). A violent shock shakes the whole weed-filament, the following things occurring simultaneously: the first cell shuts itself in the place where the hole is; the second separates itself from the third cell, which is still intact, at which the filament between cell 2 and 3 bends through, so that the two parts form an angle of ± 75°, and lastly the contents of the cell are made to a ball and devoured. The whole complex of processes has a violently explosive character.

5.40 (Fig. 12.) After the cell has been emptied a finger-formed pseudopodium appears, which behaves in exactly the same way as in the other cases.

5.47 (Fig. 13). The animal changes cell 2 for cell 3 and hangs between the two cells on his two bundles of pulling-threads.

5.48 (Fig. 14). The animal has attached itself to cell 3; the pulling-threads, very much shortened, are only fixed to this cell; there is no longer any contact with cell 2, just emptied.

5.50. The contents of cell 3 are suddenly poured into the plasm-body of the animal, where they become visible in the middle of the brown-red plasm as a green pellet. The situation between the cells of the filament remains unchanged.

We shall now give a short summary of what former observers relate about the feeding of *Vampyrella lateritia*. CIENKOWSKY (1865) is the first to describe the process, shortly, it is true, but accurately. His information comes to the following. After a *Vampyrella*-specimen has attached itself to a weed-filament — in this case of *Spirogyra* spec. — a few minutes' interval follows. Then suddenly the *Spirogyra*-cell thus attacked is seen to shift its place with a shock and at the same time to let loose the contents from the cell-wall. Shortly after this the contents pass very slowly into the plasm-body of the *Vampyrella*. After this the animal glides to the next cell, which is emptied in the same way. Thus cell after cell is robbed of its contents, till the *Vampyrella* entirely filled with food attaches itself to a weed-filament and encysts itself to digest the absorbed food. The ingestion of the cell-contents lasts 12 minutes on an average; during this time the pseudopods are either stretched out or they disappear entirely. The holes on the cell-wall are large but not clear-cut. As the animal has no hard parts we must take for granted that it is able to dissolve the cellulose-walls. Without any doubt it makes in this a deliberate choice: never did it attack a *Vaucheria* or an *Oedogonium*, even when these were purposely put before the animal; neither was food taken by total envelopment of a weed-cell.

PENARD (1889) remarks that his observations diverge from the usual opinion about the food-ingesting. This opinion means that the *Vampyrella* bores a hole into the wall of a *Spirogyra*-cell and introduces into it a pseudopodium whose task it is to seek the contents of the cell. Then PENARD himself gives the following description of the process, which he has repeatedly observed and always with the same results. After the animal has attached itself to a cell of the *Spirogyra*-filament and has drawn its pseudopodia an interval follows, during which nothing happens (so it seems at least). Then the central part of the plasm of the animal that is connected with the cell-wall withdraws from it while the outer part, in the form of a ring, remains attached to the wall; thus a vault-like cavity ("voûte") is formed in the plasm-body which rises higher and higher, till suddenly the cell-wall bursts ("se crêve") and the whole contents pass into the plasm-body. Now the animal stretches its pseudopodia again and goes away, while in the cell-wall a clearly visible tear ("déchirure") is left behind. The same author (1922) calls it "un petit trou non pas arrondi comme l'exigérait la théorie d'une dissolution de la cellulose, mais inégal et le plus souvent en étoile". (This, however, seems to be the outcome of later investigations, not published till yet). A second, sometimes also a third cell is emptied in the same way, after which the animal encysts itself. At last PENARD says once more emphatically that the ingesting of the food by *Vampyrella* takes place by means of a genuine sucking-process, in which the whole body of the animal functions as a suctorial organ ("ventouse"). A difficult coincidence is the fact that the walls of the weed-cell, as it is being emptied, do not fall together through the pression of the surrounding liquid, but, says PENARD, it is possible that, while its contents are disappearing, the cell fills itself with water through the wall.

The specimens of *Vampyrella* studied by WEST (1901) fed on the contents of *Mougeotia*-cells. He describes the process in the following way. The animal attached itself to a weed-filament and the long pseudopodia are drawn in, while at the same time from the ectoplasm shorter and broader pseudopods appear and are drawn again. Very soon after this the cell-wall is bored through and a part of the plasm-body of the animal enters the cell, causing a violently dancing movement of the granula of the vegetable cell. Now the *Mougeotia*-chromatophore begins to disintegrate at a point situated opposite the place of contact. In two hours only a part of the chromatophore and the surrounding plasm is absorbed by the animal; the final stadia of the process are not related. WEST further remarks that some observers have stated that *Vampyrella* does not perforate the cell-walls of the weeds, "but attacks them and devours their contents by breaking the filaments at the joints. It is possible that it does so sometimes, but CIENKOWSKY's original observation of the perforation of the cell of *Spirogyra* by this animal is, however, amply confirmed by the cells of *Mougeotia*, a plant which breaks at the junction of the cells much more readily than *Spirogyra*".

CASH (1905) says that his observations differ from CIENKOWSKY's, but agree with those of the later authors. After his statements the animal fastens itself with its longer and more movable pseudopodia to one of the cells of the weed-filament, *Spirogyra* or a related form, usually to the last cell. These long pseudopods have a remarkable force of contracting: they gather into a bundle on the side of the body where their presence is most urgently required. Through an effort scarcely intelligible in such a small creature, the filament on one of the joints is broken off and thus the animal gains admittance to the interior of a cell of which the contents are rapidly devoured by means of one or two finger-formed pseudopods that penetrate into the cell. As a peculiar case it is stated that a *Vampyrella*-specimen after emptying the last cell of a filament isolates the following cells one by one, through which proceeding they lie aside loose from one another, forming more or less straight angles which each other; every second of these cells is emptied then.

LLOYD (1929) first gives a summary of the observations of the Russian investigator GOBI (1925) [1]). GOBI's opinion about the process is as follows. After the animal has fastened itself, it begins to "show strain", which has the following consequences: 1. a big vacuole rises in the plasm-body, destined to receive the food, the "food-receptive" vacuole (= the "voûte" of PENARD ?); 2. the animal often jerks the filament and breaks it to pieces, or tears a single cell loose from the contact with the others. The last thing is often the case with the genus *Mesocarpus*, but not with *Spirogyra*, which proves that the cohesive force of the cells of the filament in the latter genus is greater than in the former. The food-receptive vacuole causes plasmolyse in the weed-cell and after that absorbs the contents; meanwhile the plasm-body is strained and seems to become stiff, the long pseudopodia being considerably shortened and sometimes entirely drawn back.

LLOYD, whose observations are based as well on film-pictures as on the study of living material, equally states, that bundles of pseudopods stretch themselves along the filament and pull it forcibly, but, according to him, they are drawn back before the filament breaks to pieces. LLOYD also agrees with GOBI in the opinion that a "food-receptive vacuole" occurs, but he gives an other explanation of its origin than the observer mentioned. According to LLOYD the animal touches the cell-wall, through which this wall is chemically changed such that it becomes soft in that place because the cellulose turns into hydrocellulose. Through turgor-pression this soft part of the wall bulges out and forms a "blister" in the plasm-body ot the animal, which is the same as the "food-receptive vacuole" of GOBI and the "voûte" of PENARD. The pushing away of the cells from or out of the filament is ascribed directly to the turgor-change of the cell-contents, in consequence of which fact the blister bursts. That cells were thrown off according to turgor-decrease in *Spirogyra* and *Mesocarpus* was already known (COHN, BENECKE). LLOYD finishes his statements with the remark that his observations have convinced him, that the pseudopods play no active part in the effective ingestion of the food. GOBI saw 9, LLOYD 5 cells being emptied one after another by the same animal. As to the pseudopods, which, according to GOBI, are totally or partially drawn back during the feeding. LLOYD adds, that CIENKOWSKY maintains, that they remain unchanged — this is, however, not true, see above p. 101 —, but that he himself has never observed that they were present during the whole of the process, although some were probably used as "anchors".

[1]) The periodical in which these were published is not to be had in any Netherland public library.

STUMP (1935) discovered, that some species of the Thecamoeba-genera *Difflugia*, *Pontigulasia* and *Lesquereusia* feed in some cases in the same way as *Vampyrella lateritia*; according to him there exist the following differences however. It is true that the filament of the weed bent or broke sometimes during the activity of the specimens of the mentioned species; but this was never accompanied by a sudden shock as was the case with *Vampyrella*. The way in which the cell-wall is opened, is also different: the Thecamoeba do not open the wall by suction, but by pulling; in this way irregular rents and flaws appear instead of round holes with smooth edges. The proper feeding takes place through the cytoplasmatic stream and not by a sucking action as in *Vampyrella*.

We discovered the same process in an other species of the genus *Difflugia*, *D. rubescens*; see for our observations of this case our publication in the "Proceedings" Vol. 44, 1941.

Earlier observations of one of us on *Vampyrella lateritia* (1907 a) and *Hyalodiscus rubicundus* (1907 b) also procured some information about the feeding of this species. In the well-known way *Vampyrella* fed exclusively on the cell-contents of a *Spirogyra* spec.; the process of ingestion of the food pretty well agreed with CIENKOWSKY's description of it. The cell-filament remained intact; neither were the cells isolated, nor was the filament hurled aside with a shock when the cell opened. During the feeding the pinhead-pseudopods were either active or drawn in and in the latter case only the longer ones in action, or both kinds drawn in. The feeding-process always lasted shorter than 20 minutes, generally ± 15 minutes. The holes in the cell-wall were large, round or elliptical and smooth-edged. *Hyalodiscus* only devoured the contents of *Oedogonium*-cells; here the proper feeding was finished in about 2 minutes. A remarkable variant of the process, not yet observed until then and further for all we know, was the following. After an *Oedogonium*-cell had been emptied, the animal sometimes introduced a broad, finger-formed pseudopodium into the empty cell, which attached itself to one of the separating side-walls and devoured the contents of the neighbouring cell through the hole thus made. Sometimes the contents of the adjacent cell at the other side were taken in the same way.

SAMENVATTING.

1. De beschreven populatie van *Vampyrella lateritia* voedde zich uitsluitend met den celinhoud eener *Mougeotia*-soort.
2. De tijdens de voedselopname gewoonlijk uitgestrekte lange pseudopodiën oefenden daarbij waarschijnlijk op de cellen van den draad een trekking uit, die op het oogenblik van het opengaan der cel sterke dislocaties van den draad ten gevolge had.
3. Het eigenlijke ledigingsproces liep in enkele minuten af.
4. Na afloop daarvan stak het dier een vingervormig pseudopodium in de leege cel, a.h.w. om deze op eventueele resten van haar inhoud te onderzoeken en deze nog op te nemen.
5. Gewoonlijk werden eenige cellen achter elkaar, de grootere tot een maximum van 3, de kleinere tot een van 7, geledigd.

6. De openingen in den celwand waren rond of breed-elliptisch en hadden gladde randen.

7. Een ingrijpende verandering van het plasma der wiercel vóór het doorbreken van den wand kon niet worden geconstateerd.

8. Het eigenlijke openingsproces van den wand der wiercel is waarschijnlijk de resultante van drie factoren: 1. een chemische verandering van den wand door het dier op een vrij scherp begrensde plek; 2. een druk van binnen uit door verhoogden turgor als gevolg van een sterke vacuolisatie; 3. een trekkende (zuigende) werking, uitgeoefend door het dier. De onderlinge verhouding van de grootte dezer componenten kan van geval tot geval variëeren.

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[1]) In our previous paper in the "Proceedings" (1940) we mentioned in the record of literature a publication of S. MIHAÉLOFF, communicated in the "Bulletin de l'Institut d'Egypte", Vol. **18**, 1936. We took this from a quotation of G. ENTZ Jr. in the "Archives Neérlandaises de Zoologie", T. III, 1938, as we did not know then the article itself. Having read it since we feel obliged to declare that it is obviously one of the worst cases of plagiarism anywhere to be found. It contains: 1. a statement on artificial amoebas; 2. a description of *Protamoeba primordialis* KOROTNEFF; 3. observations on the artificial production of Thecamoeba-shells; 4. observations on the ingestion of food by *Vampyrella lateritia*; 5. diagnoses of two "new" species of Protozoa, a Rhizopod and a Flagellate. The author asserts that his statements are based on his own observations; we, however, affirm emphatically that all the so-called observations of MIHAÉLOFF are actually taken from E. PENARD and that the words in which these "observations" are communicated are copied with some slight modifications from PENARD's publication: "Les Protozoaires considérés sous le rapport de leur perfection organique" (Genève, 1922), this authors name not being mentioned at all. The height of impudence is the way in which the two new species are created. The diagnose of the Rhizopod, *Amphiterma* (must be: *Amphitrema*) *aegyptica* n. sp., is an almost verbatim copy of PENARD l.c., but here it refers to *Amphitrema lemanense*, a species discovered by PENARD in the Lake of Geneva. The origin of the diagnosis of the Flagellate, *Sphaerulla* (must be: *Sphaerula*) *nili* n. sp., is even more remarkable. It is also found almost verbally in PENARD's publication, but it is composed by MIHAÉLOFF of the diagnoses of two new species described by PENARD, sc. *Cryptomonas ovata* and *Sphaeroeca* sp.

How to qualify this bare-faced falsification of a scientific text, baffles us completely, but let the conviction that this case is an unparalleled one be our comfort.

Psychologie. — *Das Problem des Ursprungs der Sprache.* I. Von G. RÉVÉSZ. (Communicated by Prof. A. P. H. A. DE KLEYN.)

(Communicated at the meeting of December 27, 1941.)

Inhalt:

1. *Einleitung.*

Bei Betrachtung der menschlichen und tierischen Welt fällt uns eine ganz besondere Erscheinung auf, die für das anthropologische Grundproblem von der grössten Bedeutung ist.

Während die jetzt auf der Erde lebenden Tiere Jahrtausende, vermutlich 20—30.000 Jahre lang, in ihren Verhaltungsweisen, Trieben, Affekten, Bedürfnissen, Leistungen, sozialen Formen, ihrer psychobiologischen Beschaffenheit *keine Veränderung* zeigen, hat das Menschengeschlecht während dieser Zeit eine bedeutende *Geschichte* gezeigt. Tiergemeinschaften traten immer wieder auf, ohne nennenswerten Einfluss auf die folgenden Generationen auszuüben, während in dieser Zeit die Menschheit durch verschiedene Etappen hindurch gegangen ist und dabei eine Entwicklung durchgemacht hat, die durch Ueberlieferungen, Erfahrungen und Leistungen kollektiver und individueller Art bestimmt ist.

Der Elefant im Urwald hat sich vor 10.000 Jahren genau so verhalten wie jetzt. Er hat seinen Rüssel gerade so zum Greifen, zum Tasten, zum Trinken benützt wie heute. Seine Stosszähne dienten in der Tertiärzeit genau so zum Abreissen der Baumrinde, zum Aufwühlen des Bodens, wie jetzt. Die Bienen haben ihren Nahrungserwerb in der vorgeschichtlichen Zeit eben so zwangs- und zweckmässig organisiert und ihre Feinde eben so grausam verfolgt wie gegenwärtig. Auch der junge Esel sprang vor Tausenden von Jahren genau so munter und komisch umher wie heute, und die Krokodile dürften zur Zeit des Leviathans nicht viel liebenswürdiger gewesen sein als nun. Demgegenüber sah der Mensch in der paläolithischen Zeit anders aus; er besass eine andere Kultur als der geschichtliche Mensch. Auch der Franzose wird in der Epoche der Völkerwanderung eine andere, primitivere geistige Konstitution gehabt haben als in der Periode der grossen kulturellen Entwicklung seines Landes.

Diese Invariabilität der Tiere erklärt sich daraus, dass sie im höchsten Masse an die Umwelt gebunden sind, sich der Natur vollkommen unterwerfen und den geophysischen