cial cases when, for example, the abstract is too brief or pertinent matter is known to be available in the original which does not appear in abstract.

From the reader's viewpoint, references to abstract journals should be made when they represent the basis of the study. References to originals, then, are optional even if helpful. On the other hand, references to original publications should be made if they are the basis of discussion and conclusions. The references to the abstract journals, then, are optional but still may be helpful. Where space permits, both the abstract entry and the original should be cited.

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## Concerning the Genera of Amebas

In recent literature the nomenclature of certain free-living amebas has been the subject of considerable discussion (S. O. Mast and P. L. Johnson. *Arch. Protistenk*, 1931, **75**, 14–30; A. A. Schaeffer. *Turtox News*, 1937, **16**, 114; 1938, **16**, 96–97; S. O. Mast. *Turtox News*, 1938, **16**, 46–48; Nolan E. Rice. *Biol. Bull.*, 1945, **88**, 139–143; R. G. Short. *Biol. Bull.*, 1946, **90**, 8–18; R. R. Kudo. *J. Morphol.*, 1946, **78**, 317–352; 1947, **80**, 93–143; C. G. Wilber. *Trans. Amer. Mic Soc.*, 1947, **66**, 99–101). The organisms concerned are the following:

(1) *Amoeba proteus* Leidy, also known as *Chaos diffluens*—the common large laboratory ameba.

(2) *Chaos carolinensis* (Wilson), also known as *Amoeba carolinensis, Pelomyxa carolinensis,* and *Chaos chaos*—the well-known "giant ameba" (Schaeffer, 1937; P. F. Brandwein, P. Penn, and C. Schiel. *Science*, 1943, **98**, 431; Kudo, 1946).

(3) *Pelomyxa palustris* Greeff, or *Pelomyxa villosa* Leidy, a less well-known "giant ameba."

Protozoologists who have studied these organisms have no difficulty in distinguishing them from each other and from most other amebas. The confusion is principally in terminology. What should we call organisms 1 and 2? Should organisms 2 and 3 be placed in the same genus? Consideration of these questions leads to the broader question: What are the generic characters of the amebas? The purpose of the present note is to discuss the third one of these questions in the hope of elucidating the answers to the first two.

Schaeffer (Carnegie Instn. Wash., Dept. Marine Biol., Publ. 345, Vol. 24, 1–116), Short, and others have pointed out that organisms 1 and 2 resemble each other in general form. The shape and number of pseudopodia, the ridges on the pseudopodia, and the manner of locomotion are all very similar. For these reasons Schaeffer considered them both to be in one genus, and he designated that genus as *Chaos*. Short, for more or less the same reasons, also considered them to be in the same genus, but decided that the generic name should be *Amoeba*. These two organisms differ in size and in the number and size of nuclei. The first organism has a single large nucleus; the second, several hundred small nuclei. The structure and mitotic behavior of the nuclei, however, are similar in the two species (see Short and Kudo).

Both Mast and Johnson, because of uncertainty concerning the definition of the genus *Chaos*, considered that organism 1 should be in the genus *Amoeba* and that organism 2 should be placed in the genus *Pelomyxa*. Rice considered the differences in size, in number and size of nuclei, number and character of contractile vacuoles, and type of reproduction (binary vs. trinary) sufficient to warrant separate genera and also suggested that the genera be called *Amoeba* and *Pelomyxa*. Kudo arrived at the same conclusion for more or less the same reasons given by Rice.

However, the genus *Pelomyxa*, certainly as represented by the type species, *P. palustris* Greeff 1874, is quite a different animal from organism 2. It is true, as pointed out by Kudo, that both organisms are large and have many nuclei, but in body shape and in the manner of locomotion the two animals are very different. *P. palustris* does not ordinarily form pseudopodia, and certainly it does not locomote by means of pseudopodia.

A very detailed description of *Pelomyxa* is that of Leidy (*U. S. geological survey of the territories*, 1879 Vol. 12), who described *P. villosa*. It is highly probable that *P. villosa* and *P. palustris* are the same species (see Leidy; E. Penard. *Faune rhizopodique du Bassin du Leman*, Geneva, 1902; M. Leiner, *Arch. Protistenk*, 1924, **47**, 253–307; and Kudo, 1946), and Leidy has given an excellent description of the locomotion of this organism. He stated that it is more or less leech- or slug-like in shape, with broader anterior end, and that it progresses through the projection of wave-like or hemispherical expansions of the clear ectoplasm in front and on the sides (when turning). It is very definite in Leidy's description that the organism does not normally locomote by means of pseudopodia but by means of protoplasmic waves. He states: "I have not observed *Pelomyxa villosa* assume the branching condition of *Amoeba proteus*, but under undue pressure I have seen it project one or two digitate pseudopods, as in the latter." The locomotion of *P. villosa* is therefore quite different from that of organism 2, which locomotes by means of pseudopodia, as does organism 1.

The type of locomotion of an ameba is one of its principal taxonomic characters. The generic characters, which are based largely on form and locomotion, have been clearly defined by Schaeffer (Publ. 345), but these have been either ignored entirely or merely mentioned briefly in the more recent literature.

For instance, Wilber's recent paper contains the following quotation from a paper by Calkins (*Trans. 15th int. Congr. Hyg. Demogr.*, 1912, 1–19) which was originally published in 1912, 14 years before the monumental paper by Schaeffer. Calkins said: "The nature of the pseudopodia and ectoplasmic and endoplasmic differentiation are unsafe diagnostic characters by which to identify amoebae, for these have been shown to vary widely in the same species under different conditions of environment." This statement is not valid now, and

certainly should not have been considered valid at any time since 1926.

Furthermore, earlier serious students of the amebas —for example, Leidy, Penard, and Cash and Hopkinson (*Publ. Ray. Soc.*, 1905, **85**, 1–150)—recognized that the method of locomotion and the form of the pseudopodia were definite taxonomic characters and always included the details of locomotion in each taxonomic description. One of Schaeffer's major contributions was that he systematized these descriptions and defined the genera in such a way as to separate groups of species which differed from each other in form and in methods of locomotion.

Once we recognize that the method of locomotion is a valid generic character and that the number of nuclei can also be used as a generic character (as in the Endamoebidae, *e.g. Dientamoeba*), then the solution to the question of what to call organisms 1 and 2 is obvious. Let us consider that there are three genera: *Amoeba, Chaos,* and *Pelomyxa,* and that the type species are the organisms commonly known as *proteus, carolinensis,* and *palustris,* respectively.

This simple procedure merely divides the genus *Chaos* into two genera: *Amoeba* with one nucleus and *Chaos* with many nuclei. It violates no principles pertaining to generic characters as defined by Schaeffer (Publ. 345). It violates no international rules, except for the spelling of *Amoeba,* which perhaps should be *Amiba,* because in 1830 Ehrenberg changed the original 1822 spelling of Bory. A return to *Amiba,* however, would probably not be acceptable to most zoologists.

The question of the specific names of organisms 1 and 2 is still open to discussion, *i.e.* whether organism 1 should be called *Amoeba proteus* or *A. diffluens* and whether organism 2 should be called *Chaos carolinensis* or *C. chaos.* The answers to these problems hinge on the question of what organism some of the early investigators really saw. This cannot be determined with certainty. Therefore, the simplest solution seems to be to accept the earliest name that is accompanied by a description so adequate that modern students of the amebas feel fairly certain in recognizing the same organism at the present time. The earliest description which most students are willing to accept unequivocally as applying to organism 1 is that of Leidy; the species, therefore, should be *proteus,* as emended, however, by Schaeffer in his *Ameboid movement* (1920). For organism 2 the earliest unequivocal description is that of Wilson (*Amer. Nat.,* 1900, **34**, 535–550); the species, therefore, should be *carolinensis.*

This gives us the three names *Amoeba proteus, Chaos carolinensis,* and *Pelomyxa palustris* as those which should be applied to organisms 1, 2, and 3, respectively.

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## Effect of Formaldehyde on *Picea* and *Tsuga* Herbarium Specimens

F. R. Fosberg (*Science,* September 12, 1947, pp. 250–251), in reporting the use of formaldehyde-alcohol mixtures in the preparation of herbarium specimens, suggests that the use of this technique might prove beneficial in preparing such specimens of *Tsuga* and *Picea* and the cones of *Abies,* all notorious for disarticulation upon drying.

To test this suggestion, specimens were prepared from available fresh material of both *Tsuga* and *Picea,* green cones of *Abies* being out of season. Specimens included one species of *Tsuga* (*T. canadensis*) and 10 species of *Picea* (*asperata, bicolor, excelsa, glauca, mariana, Omorika, orientalis, polita, pungens,* and *Wilsonii*). The specimens were made in duplicate, one of each species to be dried by the customary method to serve as a check on the chemically treated one. The specimens to be treated were dipped in a formaldehyde-alcohol mixture made according to Fosberg's formula and then placed in a plant press with the untreated ones. Artificial heat was used to facilitate drying.

Examinations made during the drying period showed, as expected, that the chemically killed material was drying faster than the untreated specimens. In both cases, however, as drying became complete, the needles fell from the twigs if they were touched or slightly jarred. There were some discernible specific differences in the ease with which the needles broke free, the heavier-leaved Asiatic species showing more resistance to fracture than some of the finer-leaved species.

From these results it was concluded that this type of chemical treatment is without value in the preparation of herbarium specimens from this type of material.

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