Arch. Protistenk. **121** (1979): 20 – 63

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Review of the Taxonomic History and Nomenclature of the Yellow-Green Algae

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Summary

The taxonomic history of the yellow-green algae is reviewed with emphasis on classification above the rank of genus. Numerous nomenclatural situations in need of rectification or clarification are discussed. At the ordinal level Heterocapsales is rejected because *Heterocapsa* is a genus of dinoflagellates. As a substitute name Heterogloeales is proposed. At the family level Heterogloeaceae is proposed to replace Heterocapsaceae, an invalid name, while Heterococcaceae is proposed to replace both Heterocloniaceae, an invalid name, and Heterodendraceae, an illegitimate name. At the generic level *Brachynematella* is proposed as a substitute name for the later homonym *Brachynema* ÅLVIK, *Sphagnoikos* for the later homonym *Fremya* P. A. DANGEARD, *Heterocalycina* for the later homonym *Heterocalyx* BURSA, *Xanthonema* for the later homonym *Heterothrix* PASCHER, and *Radiosphaerella* for the later homonym *Radiosphaera* PASCHER. *Meringosphaera* subg. *Eumeringosphaera* sect. *Raphidosphaera* is elevated to generic rank. The type species of *Bumilleria* is shown to be *B. borziana* WILLE rather than the universally cited *B. sicula* BORZÌ. The type species of *Characiopsis* is shown to be *C. borziana* LEMMERMANN rather than *C. minuta* (BRAUN) BORZÌ or *C. pyriformis* (BRAUN) BORZÌ. The type species of *Neonema* is shown to be *N. quadratum* PASCHER rather than *N. pumilum* (W. and G. S. WEST) PASCHER. The type species of *Pseudostaurastrum* is shown to be *P. enorme* (RALFS) CHODAT rather than *P. hastatum* (REINSCH) BOURRELLY. A summary of names of higher taxa in the yellow-green algae is appended. For each name is given an indication of its status in accordance with the International Code of Botanical Nomenclature and a general guide to its application.

Introduction

The yellow-green algae comprise a relatively small group of organisms which were thought by most phycologists prior to 1970 to represent a single major phyletic line. (The occasional treatment of *Vaucheria* separate from other yellow-green algae will be discussed below). The lowest rank assigned this assemblage is that of order (the traditional zoological treatment in which the siphonous and filamentous forms are excluded, e. g., Heterochlorida of the class Phytomastigophorea in the system proposed by The Committee on Taxonomy and Taxonomic Problems of the Society of Protozoologists, J. Protozool. 11: 10. 1964), while the highest rank is that of division or phylum (e. g., Xanthophyta in DEDUSENKO-SHCHEGOLEVA and HOLLERBACH 1962). Most commonly, these algae are assigned the rank of class (Heterokontae, Heterocon-

1) Offered in memory of the late Professor Dr. BOHUSLAV FOTT.

tae, or Xanthophyceae) coordinate with Chrysophyceae and Bacillariophyceae within the division or phylum Chrysophyta or, in recent years, within the more broadly circumscribed phyletic line Chromophyta (e. g., CHRISTENSEN 1962, who included therein not only Xanthophyceae, Chrysophyceae, and Bacillariophyceae, but also Cryptophyceae, Dinophyceae, Rhaphidophyceae, Haptophyceae, Craspedophyceae, and Phaeophyceae).

PAPENFUSS (1955) has provided a succinct but comprehensive characterization and taxonomic history of the yellow-green algae through 1953. The greatest contributor was ADOLF PASCHER, who summarized his prodigious wealth of original observations in a monumental treatment in "Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz" (1937—1939). In this work Pascher gave unqualified recognition to 89 genera comprising 332 species and in addition discussed approximately 20 genera and 100 species in terms of varying degrees of uncertainty regarding biological validity and taxonomic placement. Of the total, 71 genera and 309 species were of his authorship! Since the publication of PASCHER's monograph, taxonomic activity in the yellow-green algae has proceeded at a moderate pace, but nonetheless has resulted in the recognition of 28 new genera.

Vaucheria A. P. DE CANDOLLE (1801) has been allied alternatively with the green algae and the yellow-greens, with biochemical and flagellar details presumably settling the matter in favor of the latter (cf. PAPENFUSS 1955, p. 140). Three proposals have been made to segregate this genus from the remainder of the yellow-green algae. SAKISAKA and SINOTO (1930), in establishing a scheme of classification for the plant kingdom based at the highest levels on flagellar patterns, aligned *Vaucheria* with green algae, mosses, liverworts, etc. in the subphylum Isocontae coordinate with the subphylum Heterocontae (the remainder of the yellow-green algae) within the phylum Dicontophyta. MAEKAWA (1953, 1960) also accorded major significance to the combination of heterokont flagellation in the spermatozoid and isokont flagellation in the coenozoospore of this genus. On this basis, together with an alleged difference in pigmentation between the two types of motile cells, he established the phylum Vaucheriophyta, placing the remainder of the yellow-greens in the phylum Chrysophyta (as the class Heterocontae). KIMURA (1953) united *Botrydium* WALLROTH (1815), with multinucleate vesicles, and *Vaucheria*, with multinucleate nonseptate filaments, in the phylum Siphonophyta. Later (1963) he downgraded the taxon to the rank of class and changed its name to Xanthosiphonophyceae, coordinate with the Xanthophyceae within the phylum or division Chrysophyta. There appears to be no support in current literature for segregating *Vaucheria* from other yellow-green algae at such a high level.

In 1970 the quiet waters of yellow-green algal taxonomy were roiled by the proposal that a new class be segregated from the Xanthophyceae primarily on the basis of cytological and ultrastructural characters. Working with 15 species representing 12 genera of coccoid yellow-green algae, HIBBERD and LEEDALE (1970, 1971a and b, 1972) concluded that there were two distinct structural series, the difference being most apparent in the motile stages. "The zoospores in one series have the same basic

morphology as described for the zoospores of *Chlorosaccus*, *Botrydiopsis*, and *Tribonema* by LUTHER (1899), who separated these genera from the green algae to form the basis of a new class, the Heterokontae... In contrast, zoospores of certain other species hitherto placed in the Xanthophyceae have an entirely different morphology" (HIBBERD and LEEDALE 1971). These differences concern the size and construction of the eyespot, the location and form of the flagellar swelling, and the form of the pyrenoid in the vegetative cell, *inter alia*. In representatives of the new class (Eustigmatophyceae) the eyespot is a large, orange-red body at the extreme anterior end of the zoospore, independent of the single plastid, consisting of an irregular group of droplets without bounding membranes and with no membranes around the whole complex; the flagellar swelling is located at the proximal end of the anteriorly directed hairy flagellum; the pyrenoid occurs only in vegetative cells, projecting from the inner face of the lobed plastid often on a narrow stalk, surrounded by flat plates of a photosynthate, the matrix not traversed by thylakoids. In Xanthophyceae *sensu stricto*, by contrast, the eyespot is part of one of the two or more plastids; the flagellar swelling is on the posteriorly directed smooth flagellum; pyrenoids when present occur in both zoospores and vegetative cells, semi-immersed with no surrounding photosynthate (except perhaps lipid) and with normal three-thylakoid lamellae always entering the matrix. HIBBERD and LEEDALE noted still other ultrastructural differences and cited biochemical evidence in support of their separation of the yellow-green algae into two classes — the disclosure by WHITTLE and CASSELTON (1969) that in three eustigmatophycean species the major xanthophycean xanthophyll, at that time identified as antheraxanthin, is replaced by a pigment corresponding in absorption spectrum and Rf values to violaxanthin. Recent studies emphasize the correlation between cytological and biochemical characters when eustigmatophytes are compared with xanthophytes (WHITTLE and CASSELTON 1975, in which the major xanthophycean xanthophyll is reidentified as diadinoxanthin; ANTIA et al. 1975; WHITTLE 1976).

The impact of the introduction of the concept of the Eustigmatophyceae on the taxonomy of yellow-green algae is being felt slowly but surely. HIBBERD (1972) proposed elevating the Eustigmatophyceae to the rank of division (Eustigmatophyta), which LEEDALE (1974) considered as constituting its own kingdom coordinate with six other algal kingdoms. (In LEEDALE's classification the heterokont kingdom comprises five phyla: Xanthophyta, Chrysophyta, Bacillariophyta, Phaeophyta, and Oomycota.) Recognition of the phylum Eustigmatophyta was given by MARGULIS (1974). In my opinion, the latter proposals result in excessive hierarchical inflation. I prefer to recognize the class Eustigmatophyceae within the Chromophyta. Authors who recognize the class Eustigmatophyceae include ROUND (1973), LEE and BOLD (1973), STEWART (1974), HIBBERD (1974, despite his 1972 proposal), and ANTIA et al. (1975). Apart from the work of HIBBERD and LEEDALE, a new genus has been established within the class (*Pseudocharaciopsis* LEE and BOLD 1973) and two species formerly assigned to *Nannochloris* (green algae) and *Monallantus* (yellow-green algae) have been transferred into the class (ANTIA et al. 1975).

Not all taxonomists are prepared to recognize the Eustigmatophyceae, however. FOTT (1974), for example, reserved the rank of class for a line of algal advance comprising a spectrum of somatic expressions, extending from monads to filamentous thalli. He argued against the adoption of "electron microscopical 'classes'", maintaining that "the system of higher taxonomic units cannot be based solely on submicroscopical criteria". In fairness to FOTT, it should be pointed out that recent information regarding eustigmatophycean pigmentation was not available to him at that time. It is interesting to note that the lack of a spectrum of somatic types within the diatoms did not deter him from considering that group as a class. Presumably, their sheer number and diversity within the confines of unicellularity were overriding factors in this apparent inconsistency of treatment.

The segregation of eustigmatophycean forms from other yellow-green algae involves some interesting taxonomic and nomenclatural problems. The chief difficulty is that the ultrastructural and biochemical characters that differentiate the two phyletic lines are not discernible in older illustrations and descriptions or even in herbarium specimens so that some doubt always attends the identification with existing species of strains used in current research. Nonetheless, two genera previously assigned to the Xanthophyceae have been removed to the Eustigmatophyceae on the basis of characters shown by strains identified with their type species, namely, *Vischeria* PASCHER (HIBBERD and LEEDALE 1970, 1971b, 1972) and *Chlorobotrys* BOHLIN (HIBBERD 1974). Whether other species assigned to these two genera are also eustigmatophycean remains to be shown. The disposition of *Pleurochloris* PASCHER is more problematical. Strains identified by HIBBERD and LEEDALE as *P. commutata* PASCHER and *P. magna* J. B. PETERSEN proved to be eustigmatophycean, while *P. meiringensis* VISCHER was xanthophycean. *Pleurochloris* is thus seen to be diphyletic, held together by certain secondary and tertiary characters that have evolved convergently. Although *P. commutata* is the type of its genus, the transfer of *Pleurochloris* to the Eustigmatophyceae is clouded by uncertainty that PASCHER's material and that studied by HIBBERD and LEEDALE are conspecific. In a recent personal communication, HIBBERD has disclosed his decision to establish a new species and a new genus to accommodate the eustigmatophycean strain previously identified as *P. commutata*, leaving *Pleurochloris* (and its type species) in limbo. The fate of *P. meiringensis*, a xanthophyte, is not clear. Other problems at the generic level are discussed by HIBBERD and LEEDALE (1972).

In view of the existence of PASCHER's monograph, the yellow-green algae promised to be a relatively trouble-free group to process for the Index Nominum Genericorum (scheduled to be published in 1979). Dr. HANS LUTHER prepared 142 entries which were edited by Professor G. F. PAPENFUSS and submitted to the International Bureau for Plant Taxonomy and Nomenclature (Utrecht) in 1959. These entries together with eight others that I had previously prepared in connection with nomina generica conservanda covered the group as completely as was known at that time. In 1969 I succeeded Professor PAPENFUSS as editor for the algal part of the Index. Prompted by the desirability of ascertaining the effects on the Index that the re-

cognition of a eustigmatophycean phyletic line might have, I undertook a review of the entire group of yellow-green algae, which ultimately led to rechecking all previously submitted bibliographic, nomenclatural, and taxonomic data. As a result, many items were discovered that call for rectification or clarification.

Names of Categories above the Rank of Genus

Kingdoms

The present (Seattle) version of the International Code of Botanical Nomenclature (ICBN) does not provide for multiple kingdoms. According to Art. 4, all plants belong to the plant kingdom (Regnum Vegetabile). If certain groups of algae were to be removed to separate kingdoms, as LEEDALE (1974) proposed, the nomenclature of those groups would be removed from the jurisdiction of the botanical code. Growing recognition of the fact that an ever increasing number of biologists find the two-kingdom system (plants and animals) unsatisfactory led to proposals to modify the ICBN to accommodate multiple plant kingdoms (Voss 1975). These proposals were accepted by the Nomenclature Section of the Twelfth International Botanical Congress at Leningrad in July 1975. Rules governing the names of kingdoms, however, were not discussed at Leningrad. In any event, LEEDALE did not propose a name for the eustigmatophyte kingdom, but merely stated that it is coextensive with the phylum Eustigmatophyta.

Divisions and/or Phyla

The category "divisio" ("division", "embranchement", "Abteilung", "тип") as recognized by the ICBN is currently considered equivalent in rank, if not in connotation, to "phylum" in zoological nomenclature. At one time, however, division was considered subordinate to phylum (cf. WETTSTEIN 1901, p. 12), and in fact the first treatment of the yellow-green algae as a group above the rank of class was as the division ("Abteilung") Heterokontae of the phylum ("Stamm") Chrysophyta (PASCHER 1931, p. 324). To my knowledge all contemporary phycologists use either one or the other term, or both interchangeably. Some prefer phylum, despite the lack of sanction by the ICBN.

There are no rules governing the formation of names of divisions and such names are exempt from the principles of typification and priority. Recommendation 16A, however, states that the name of a division is preferably taken from characters indicating the nature of the division as closely as possible; it should end in -phyta. Names of subdivisions, classes, and subclasses should be similarly formed and end in -phytina, -phyceae, and -phycidae, respectively (the two latter endings being applicable only to algae). An important change in Rec. 16A was adopted at Leningrad whereby it will be recommended that names of divisions, subdivisions, classes, and subclasses be taken either from distinctive characters or from the name of an included genus. A name of the latter form is automatically typified; for such names the rule of automatic tautonymy with appropriate ending (as exemplified in Art. 19) governs the name of the nomenclaturally typical subdivision of a division, the nomenclaturally

typical subclass of a class, and the nomenclaturally typical suborder of an order. It will also be recommended that in choosing among typified names for a taxon above the rank of family, authors should follow the principle of priority. Whether or not a name is subject to the principles of typification and priority, it must conform to the rules for effective and valid publication. Several divisional names have been used in the yellow-green algae, either for the group as a whole or for segregates, but only two are valid: Heterokontae (or the orthographic variant Heterocontae) and Xanthophyta. As mentioned above, Heterokontae was initially applied to a division in the phylum Chrysophyta by PASCHER (1931, p. 324), but without a validating description. In his monograph, PASCHER (1937) provided a description but did not specify the rank, merely referring to the group as a "Reihe". Nonetheless, its position in the hierarchy — between phylum and class (cf. pp. 175, 203) — is tantamout to divisional rank and thus is in agreement with PASCHER's earlier treatment. Meanwhile, the orthographic variant Heterocontae was validly proposed for a division by DIELS (1936, p. 14). If either Heterokontae or Heterocontae is applied at this level, it should be given the ending -phyta in accordance with Rec. 16A. Xanthophyta was proposed by HOLLERBACH and POLYANSKY (1951, pp. 14, 188; not POLYANSKY and HOLLERBACH as cited by SILVA 1962, p. 838). Xanthophyceae DILLON (1963) was designated a phylum, but with an ending not in accordance with Rec. 16A. When the ending is corrected, the name becomes Xanthophyta. The same objection could be raised against Xanthophyta as was raised by PASCHER (1937, p. 203) with regard to Xanthophyceae, namely, that *ξανθός* (yellow) is a color displayed by yellow-green algae only when in poor health. As for segregate names, Vaucheriophyta MAEKAWA (1953, without diagnosis; 1960, without Latin diagnosis), Siphonophyta KIMURA (1953), without diagnosis), and Eustigmatophyta HIBBERD (1972, without diagnosis) remain to be validated.

Subdivisions or Subphyla

The only name that has been applied at this rank is subphylum Heterocontae SAKISAKA and SINOTO (1930), but without a diagnosis and hence invalid.

Classes and Subclasses

The yellow-green algae display the entire spectrum envisioned in the idealized concept of the evolution of vegetative form within the algae: rhizopodial (amoeboid) cells or plasmodia; individual flagellated cells (monads); gelatinous aggregates of nonmotile cells (palmelloid colonies); nonmotile cells occurring singly or in colonies, with a firm cell wall usually attached to the substrate by a short mucilaginous stalk (coccoid forms); uniseriate filaments, simple or branched; and multinucleate vesicles or nonseptate filaments. Within the Reihe Heterokontae, PASCHER (1937—1939) set apart each of these evolutionary lines as a class comprising usually one order (in one instance two orders), as follows: Rhizochloridineae (Rhizochloridales), Heterochloridineae (Heterochloridales), Heterocapsineae (Heterocapsales), Heterococcineae (Heterococcales), Heterotrichineae (Heterotrichales or Tribonematales, Heterocloniales),

and Heterosiphonineae (Botrydiales). In view of the confusing fact that *Heterococcus* R. CHODAT (1907) is a member of the Heterotrichineae rather than the Heterococcineae, ETTL (1957) substituted Heterosphaerineae for the latter name. In accordance with Rec. 16A, DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962) changed PASCHER's class names to end in -phyceae (Rhizochlorophyceae, Heterochlorophyceae, Heterocapsophyceae, Heterococcophyceae, Heterotrichophyceae, Heterosiphonophyceae). In systems of classification in which the yellow-green algae are treated as a single class, PASCHER's classes are usually ignored and only his orders are used. STARMACH (1968), however, developed a full hierarchy by recognizing each of PASCHER's classes as a subclass (Rhizochlorophycidae, Heterochlorophycidae, Heterocapsophycidae, Heterococcophycidae, Heterotrichophycidae, and Heterosiphonophycidae), which he placed within the class Xanthophyceae.

The application of names of categories exempt from the principle of typification must be determined by the circumscription method. Accordingly, while PASCHER's class names are all valid, none applies to the yellow-green algae in their entirety. Xanthomonadina DEFLANDRE (1952) is applicable to the rhizopodial and monad forms jointly, a protozoological concept. Heterokontae LUTHER (1899), Heterocontae OLTMANNS (1904), and Xanthophyceae P. ALLORGE ex FRITSCH (1935, p. 470), however, are valid class names which may be applied to the entire group. PASCHER chose Heterokontae in preference to Xanthophyceae (not for a class, however, but for a division) mainly because it was an older name, but also because of the etymological objection to Xanthophyceae already discussed (under Xanthophyta). With regard to the competition between Heterokontae and Xanthophyceae, PAPENFUSS (1955, p. 140) remarked: "... since this appellation [Xanthophyceae] conforms to the majority of class names of algae in connoting color and in terminating in -phyceae, it has met with favor in many quarters." CHADEFAUD (1960, p. 213 etc.) used the designation Xanthophycinées in place of Xanthophyceae, but this name, being in French rather than in Latin form, is invalid.

With regard to segregate class names, Eustigmatophyceae HIBBERD and LEEDALE (1971) is valid, while Xanthosiphonophyceae KIMURA (1963, without diagnosis), encompassing vesicular and siphonous yellow-greens, is invalid.

At the rank of subclass, each of the six names derived by STARMACH from PASCHER's class names but invalidly published is applicable to only part of the yellow-green algae. TILDEN (1935, p. 337), however, treated the entire group as a subclass (Tribonemeae), which she assigned to the class Chrysophyceae along with diatoms, chrysomonads, dinoflagellates, cryptomonads, chloromonads, and euglenids. Her circumscription of Chrysophyceae is thus seen to be similar to that of the Chromophyta of recent authors. Tribonemeae is a valid name, although its ending is not in accordance with Rec. 16A.

Orders

Confusion surrounds the correct form and application of names of the orders of yellow-green algae, resulting largely from successive changes in the ICBN. The Cam-

bridge Code (1935, Rec. IX) stated that "orders are designated preferably by the name of one of their principal families, with the ending -ales". Like all names at that time, ordinal names were subject to typification and priority. A significant change was effected at the Stockholm Congress (1950): hereafter, the name of an order had to be taken from that of its type family, with the ending -ales (Art. 27). At the Montreal Congress (1959) retrogressive steps were taken: permission was given for an ordinal name to be formed in any manner, the only stipulation being that if it is based on the stem of the name of a family, it must have the ending -ales; names of taxa above the rank of family were exempted from both typification and priority (but not from the requirements of effective and valid publication). Allegedly because of the difficulties of typifying ordinal names (presumably those not based on the name of a family), the spermatophyte taxonomists, over the protests of numerous phycologists, theoretically opened the door to chaos. Fortunately, most phycologists seem willing to follow pre-Montreal rules and recommendations regarding the formation and application of ordinal names, thus subscribing to the logic of Principle IV: "Each taxonomic group with a particular circumscription, position, and rank can bear only one correct name, the earliest that is in accordance with the Rules..."

Another source of confusion, singularly affecting me, is related to proposals that I made before the Montreal Congress by which names of families and subfamilies must be based on the stem of a legitimate name of an included genus, while names of orders and suborders must be based on the stem of a legitimate name of an included family. These proposals (Taxon 8: 8. 1959; Regnum Vegetabile 14: 27, 28, 30. 1959) were accepted on the floor of the Congress by the Nomenclature Section (Regnum Vegetabile 20: 54, 55, 56. 1960). Later in the session, however, a proposal was accepted to exempt ordinal and subordinal names from typification and priority. In writing the new Code, the Editorial Committee decided that my proposal concerning ordinal and subordinal names was not compatible with the exemption of such names from typification and priority. Meanwhile, before the appearance of the Montreal Code, I proposed several new names to replace ordinal names not based on a family name, or if so, based on an illegitimate family name (SILVA 1962). Upon publication of the Montreal Code, these substitute names were seen to be valid but unnecessary.

Rhizopodial Evolutionary Line

PASCHER placed the amoeboid or rhizopodial forms in the order Rhizochloridales, comprising the single family Rhizochloridaceae (1925, p. 26). At that time he included only the fresh-water genus *Stipitococcus* W. and G. S. WEST (1898), but alluded to a marine form. This second genus is *Rhizochloris* PASCHER, which was not formally published until 1932 (1932b, p. 312). However, *Rhizochloris* was illustrated with a few descriptive comments in a preliminary account (PASCHER 1917b, p. 31) which in my opinion is sufficient to constitute valid publication. Thus Rhizochloridales and Rhizochloridaceae, which at their inception appeared to be descriptive names, can be interpreted as being based on a generic name. Rhizochloridea DEFLANDRE (1952, p. 220) is the counterpart of Rhizochloridales in zoological nomenclature.

PASCHER (1937, p. 268) discussed the interesting genus *Chlamydomyxa* ARCHER (1875) as a probable member of the Xanthophyceae in connection with *Myxochloris* PASCHER (1930d), with which it shares many features and its habitat (the hyaline cells of *Sphagnum*). BOURRELLY (1968, p. 167) placed *Chlamydomyxa* along with *Myxochloris* in the Myxochloridaceae PASCHER (1937, p. 256) and even suggested the possibility of merging the two genera. The family Chlamydomyxaceae ENGLER (1897) (= Chlamydomyxidae POCHE 1913, p. 194) and the order Chlamydomyxales ENGLER (1898) (= Chlamydomyxidea POCHE 1913, p. 193) have been established to accommodate *Chlamydomyxa*.

CHADEFAUD's substitution of Xanthorhizidales for Rhizochloridales (1960, pp. 227, 242) is not valid, as it lacks a full and direct reference to the replaced name, its author, and its place of publication (Art. 33).

Monad Evolutionary Line

The monads were placed by PASCHER in the order Heterochloridales (1912, p. 10). At that time no included families were cited. The single family eventually recognized by PASCHER, Heterochloridaceae, based on *Heterochloris* PASCHER (1914), was not published until 1925 (p. 22). At its inception Heterochloridaceae was superfluous (and hence illegitimate in accordance with Art. 63) inasmuch as it included *Chloramoeba* BOHLIN (1898), the type of Chloramoebaceae A. LUTHER (1899). Heterochloridina DOFLEIN and REICHENOW (1928), Heterochloridea WALTON (1931), Heterochlorida PEARSE (1936), and Heterochloridida CHEISSIN and POLJANSKY (1963) are zoological equivalents of Heterochloridales.

FRITSCH (in WEST and FRITSCH 1927) termed the Heterochloridales a "group" and circumscribed it to include "the motile types or their obvious derivatives". He subdivided the group into three "series": Chloramoebales, in which the dominant phase in the life cycle is motile; Mischococcales, in which the dominant phase is sedentary and the individuals are united to form dendroid colonies; and Heterocapsales, in which the dominant phase is sedentary and the individuals are embedded in palmelloid colonies. Although these three series bear names of ordinal form, they cannot be considered orders inasmuch as they comprised genera rather than families.

Believing that the name Heterochloridales, being based on the superfluous family name Heterochloridaceae, would be illegitimate in accordance with the forthcoming Montreal Code, I proposed the substitute name Chloramoebales (SILVA 1962). This name, valid but unnecessary, was adopted by BOURRELLY (1968). For purposes of etymological uniformity, CHADEFAUD changed Heterochloridales to Xanthomonadales (1950, p. 790; 1960, pp. 227, 233), but this name is not valid as the conditions of Art. 32 (for the 1950 publication) or Art. 33 (for the 1960 publication) were not fulfilled. It may be noted that there is a genus of bacteria named *Xanthomonas*, a possible source of confusion speaking against the use of Xanthomonadales, even if this name were valid.

In summary, there are two available names for an order encompassing yellow-green monads: Heterochloridales and Chloramoebales.

Palmelloid Evolutionary Line

The palmelloid forms were placed by PASCHER in the order Heterocapsales. This name was published together with Heterocapsaceae by PASCHER in 1912 (p. 13), but unfortunately the genus *Heterocapsa* F. STEIN (1883) is neither a member of this order nor a yellow-green alga, but rather a dinoflagellate. Although Heterocapsaceae is thus invalid (cf. Arts. 18 and 32), Heterocapsales, not being required to be based on a family name, is valid. FOTT (1959, p. 130), without explanation, applied the names Heterogloeales and Heterogloeaceae to taxa with the same circumscriptions as Heterocapsales and Heterocapsaceae, respectively. [*Heterogloea*, a member of the Heterocapsaceae, was published by PASCHER (1930c, p. 666) as a substitute for *Chlorogloea* PASCHER (1930b, p. 407), a later homonym.] FOTT's names, however, are invalid as no reference was made to PASCHER's names and Latin diagnoses were not provided. I have not found a subsequent usage of Heterogloeales in which a full and direct reference to Heterocapsales as a replaced name is given in order to satisfy Art. 33. CHADEFAUD's substitution of Xanthocapsales (1960, p. 242) is invalid for the same reason.

Despite its valid status, Heterocapsales is hardly acceptable as an ordinal name within the yellow-green algae in view of the fact that *Heterocapsa* is a genus of dinoflagellates. Therefore, I herein validate Heterogloeales as a substitute for Heterocapsales PASCHER (1912, p. 13). The name should be cited Heterogloeales FOTT ex P. C. SILVA. The type family is Heterogloeaceae FOTT ex P. C. SILVA (see below).

In 1956 ETTL published an important revision of the yellow-green algae, with emphasis on the palmelloid and coccoid forms. Among the palmelloid forms, he recognized two new orders in addition to Heterocapsales, distinguishing them as follows: cells individual and free-living, not producing gelatinous material (Pleurochloridellales); cells enveloped by gelatinous material (Heterocapsales sensu stricto); cells producing gelatinous material on one side only (Malleodendrales). The Pleurochloridellales comprised a single family, Pleurochloridellaceae ETTL (1956, p. 423), based on *Pleurochloridella* PASCHER (1937, p. 334). The Malleodendrales comprised two families, Malleodendraceae PASCHER (1937, pp. 277, 301), based on *Malleodendron* PASCHER (1937, pp. 28, 301), and Characidiopsidaceae ETTL (1956, p. 425), based on *Characidiopsis* PASCHER (1938, pp. 330, 718, 719). *Pleurochloridella* and *Characidiopsis* had been included among the coccoid forms by PASCHER, but ETTL removed them to the palmelloid group on the basis that contractile vacuoles are present in vegetative cells throughout the life of the organism. Later, ETTL (1957, p. 223) indicated that the Characidiopsidaceae should be placed in its own order, Characidiopsidales, but this name was not validated by a diagnosis.

BOURRELLY (1968) did not choose to adopt ETTL's orders, but rather recognized a single order of palmelloid forms (Heterogloeales) comprising the four families Heterogloeaceae, Pleurochloridellaceae, Malleodendraceae, and Characidiopsidaceae.

In summary, if all palmelloid yellow-green algae are placed in one order, the only appropriate valid name is Heterogloeales FOTT ex P. C. SILVA. If additional orders

are recognized, two valid names proposed by ETTL come into consideration: Pleurochloridellales and Malleodendrales.

Coccoid Evolutionary Line

The coccoid forms, which constitute the overwhelming majority of yellow-green algae, were placed by PASCHER in the order Heterococcales (1912, p. 14), which in his RABENHORST treatment comprised ten families. As mentioned previously, *Heterococcus* R. CHODAT (1907) is a filamentous yellow-green alga and hence a member of another order, so that Heterococcales is hardly acceptable as an ordinal name applied to the coccoid group. Without explanation, FOTT (1959, pp. 126, 132) substituted the name Mischococcales for Heterococcales. (The family Mischococcaceae PASCHER (1912, p. 14), based on *Mischococcus* NÄGELI (1849, p. 80), was first assigned by PASCHER to the Heterocapsales, but later removed to the Heterococcales.) CHRISTENSEN (1962, p. 90) also used the name Mischococcales, without explanation. As mentioned previously, this name was first applied by FRITSCH (in WEST and FRITSCH 1927, pp. 300, 302) to a "series" within the "group" Heterochloridales. The first valid usage of the name in ordinal rank seems to be mine (SILVA 1962, p. 836), wherein the requirements of Art. 33 are satisfied. CHADEFAUD (1950, p. 790) substituted Xanthococcales for Heterococcales, later (1960, pp. 227, 233) changing it to Xanthosphaerales. Both substitutions are invalid as they do not satisfy the requirements of Art. 32 (for the 1950 publication) or Art. 33 (for the 1960 publication). It thus appears that the only appropriate valid ordinal name applicable to a taxon comprising all coccoid yellow-green algae is Mischococcales FOTT ex P. C. SILVA.

In an attempt to distribute the coccoid forms among more than one order, ETTL (1957, p. 223) established the family Asterogloeaceae on the basis of *Asterogloea* PASCHER (1930b, p. 420) and placed it together with the Gloeobotrydaceae PASCHER (1937/1938, pp. 320, 632) in a new order, Gloeobotrydales. This order included all coccoid forms with cells embedded in either a layered or an unlayered gelatinous matrix. ETTL also indicated that three coccoid families, viz., Chlorotheciaceae BOHLIN (1897, p. 48), Chloropediaceae PASCHER (1931, p. 324), and Characiopsidaceae PASCHER (1937/1938, pp. 321, 718), should be grouped in a new order, Characiopsidales, but this name was not validated by a diagnosis.

Gloeobotrydaceae is superfluous (and hence illegitimate in accordance with Art. 63) as this family originally included *Chlorobotrys* BOHLIN (1901b, p. 34), the type of Chlorobotrydaceae PASCHER (1915, p. 491), in addition to *Gloeobotrys* PASCHER (1930b, p. 436). ETTL's ordinal name Gloeobotrydales is thus seen to be based on an illegitimate family name, a situation allowable by the present Code but illogical in view of the requirement that family names must be based on legitimate generic names.

All known eustigmatophycean forms are of the coccoid type. No ordinal name has yet been proposed to accommodate them.

Filamentous Evolutionary Line

PASCHER first referred all filamentous yellow-green algae to his order Heterotrichales (1912, p. 18). To this name he added others based on the stem Heterotrich- in a confusing sequence: class Heterotrichineae (1932b, p. 337), *Heterothrix* (1932b, p. 344), and Heterotrichaceae (1939, p. 916). As will be pointed out later in this paper, *Heterothrix* is a later homonym and must be renamed. Since a family name must not be based on an illegitimate generic name, Heterotrichaceae also must be renamed. On the other hand, names of classes and orders are not covered by rules of formation so that Heterotrichineae (or Heterotrichophyceae) and Heterotrichales can stand.

In his monograph, PASCHER (1939, p. 915) divided the filamentous yellow-green algae into two groups, with the unbranched forms constituting the order Tribonematales PASCHER (p. 915) and the branched forms the order Heterocloniales (pp. 915, 991). In abandoning Heterotrichales, PASCHER probably reasoned that as originally circumscribed it should be equated with the class Heterotrichineae, while the two orders into which he now divided the class should both receive new names. Inasmuch as ordinal names are exempt from typification, Art. 63, covering superfluous names, does not apply, so that either Heterotrichales or Tribonematales may be used. CHADEFAUD's substitution of Xanthotrichales for Heterotrichales (1950, p. 790; 1960, pp. 226, 227) is invalid because it does not satisfy the requirements of Art. 32 (for the 1950 publication) or Art. 33 (for the 1960 publication).

Regarding the branched filamentous forms, the ordinal name Heterocloniales is valid in accordance with the present Code. It would not be valid, however, if legitimate family names were required as bases for ordinal names (as I believe they should be) since Heterocloniaceae PASCHER (1931, p. 324) is invalid, there being no corresponding generic name (cf. Arts. 18 and 32).

FOTT (1959, 1971), CHRISTENSEN (1962, 1966), and BOURRELLY (1968) all include the unbranched and branched forms in the same order (which for convenience I shall designate "A + B"). This treatment is in contrast to that of PASCHER, who recognized one order for unbranched forms ("A") and another order for branched forms ("B"). These alternative treatments underscore the uncertainty of application of ordinal names. In accordance with the present Code, by which the circumscription method, rather than the type method, presumably is used for taxa above the rank of family, Heterotrichales would seem to apply only to "A + B", Tribonematales only to "A", and Heterocloniales only to "B". FOTT's use of Heterotrichales for the combined order follows this line of reasoning. These applications are based on PASCHER's circumscriptions, however, and there is nothing in the Code to prevent the emendation of the circumscription of Tribonematales to include branched forms, as CHRISTENSEN and BOURRELLY have done. Foreseeing possible changes in the Code, the decision to use Tribonematales for the combined order could also be reached if ordinal names were subject both to typification and to rules of formation whereby they must be based on legitimate family names. In that case, both Heterotrichales and Heterocloniales would be invalid, as explained above, leaving Tribonematales as the only

available ordinal name, applicable either to "A + B" or to "A", since both circumscriptions include the type family Tribonemataceae. "B" would require a new name.

Siphonous Evolutionary Line

PASCHER originally placed the siphonous yellow-green algae in a new order, Heterosiphonales (1912, p. 21), encompassing the single family Botrydiaceae RABENHORST (1863, pp. 219, 222). In his monograph, however, he abandoned Heterosiphonales in favor of Botrydiales, a name usually attributed to PASCHER (1939, p. 1023), but in fact first proposed by SCHAFFNER (1922, p. 133). Despite the absence of a supporting family name, Heterosiphonales is a legitimate ordinal name. If *Vaucheria* A. P. DE CANDOLLE (1801, p. 20) is placed among the yellow-greens, as almost all contemporary phycologists do, a third ordinal name is available: Vaucheriales BOHLIN (1901a, p. 14), supported nomenclaturally by Vaucheriaceae RABENHORST (1863, pp. 219, 222). Botrydiales is preferred by FOTT (1959, 1971), DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962), and STARMACH (1968), while Vaucheriales is preferred by PAPENFUSS (1955), SILVA (1962), CHRISTENSEN (1962, 1966), and BOURRELLY (1968). At least one author has retained both Botrydiales and Vaucheriales: KIMURA (1953, pp. 98, 99) placed them as the only orders within his new phylum Siphonophyta, later (1963, p. 296) changed to class Xanthosiphonophyceae within the phylum Chrysophyta. CHADEFAUD also recognized two orders of siphonous yellow-greens, but his use of Xanthosiphonales (1950, p. 790, nomen; 1960, pp. 227, 230) as the name of the order containing *Botrydium* is invalid, either as a substitute for Botrydiales (lacking a reference to the replaced name) or as the name of a new order (lacking a Latin diagnosis).

In summary, there are three available ordinal names for use with siphonous yellow-green algae: Heterosiphonales, Botrydiales, and Vaucheriales. Their application is uncertain, however, because of the lack of guidance by rules of formation, typification, and priority.

Confervales

The genus *Conferva* LINNAEUS (1753, p. 1164) originally comprised 21 species of filamentous algae, representing five currently recognized classes. Hundreds of additional species were described by subsequent authors. The heterogeneity of the genus was recognized early in the 19th century, and as numerous more precisely defined genera of filamentous algae were established, *Conferva* came to serve as a repository for residual species and newly described filamentous species of uncertain affinity. The association of *Conferva* with the genus of yellow-green algae now known as *Tribonema* DERBÈS and SOLIER (in CASTAGNE 1851, p. 96), prevalent in the last quarter of the century, was largely the responsibility of LAGERHEIM (1889, p. 209), who based his emendation of the genus on *Conferva bombycina* C. AGARDH (1817, p. 78), the type of *Tribonema*. HAZEN (1902, p. 181) gave an excellent account of the history of *Conferva*. He considered *C. rivularis* L. the type of the genus, and regarding it as a species of the green algal genus *Rhizoclonium* KÜTZING (1843, p. 261), he abandoned the name

as applied to *C. bombycina* in favor of *Tribonema*. *Conferva rivularis* was shown by VAN DEN HOEK (1963) to be referable not to *Rhizoclonium*, but to *Cladophora* KÜTZING (1843, p. 262). *Conferva* had been lectotypified previously, however, by BONNEMAISON (1822, p. 198), who chose *C. rupestris* L., a species which also has been shown by VAN DEN HOEK to be referable to *Cladophora*. I intend to propose *Cladophora* for conservation against *Conferva* in the near future.

It was during the period when *Conferva* was associated with *C. bombycina*, and in fact attributed to Lagerheim rather than Linnaeus, that BORZÌ (1889, p. 68) proposed the order Confervales to include three families of yellow-green algae: Botrydiaceae, Sciadiaceae, and Confervaceae sensu BORZÌ (= Tribonemataceae). These three families were placed in three different orders by PASCHER and subsequent workers, and the logical course would be to restrict the application of Confervales to an order comprising all yellow-greens in accordance with BORZÌ's intentions. Speaking strongly against the use of Confervales in any circumscription, however, is the fact that Confervaceae DUMORTIER (1829, p. 77), as determined by its type *Conferva* L., resides in the green algae.

Of passing interest, and of no significance in determining the application of Confervales, is the fact that three of the original LINNAEAN species of *Conferva* are referable to *Vaucheria* (cf. CHRISTENSEN 1968). Had one of these three species been chosen as lectotype, there would be no conflict between Confervales and Confervaceae, as both names would be applicable to yellow-green algae.

If the foregoing discussion has called attention to the need to subject ordinal names to rules of formation, typification, and priority parallel to those now governing family names, one of my purposes in writing this paper will have been accomplished.

Suborders

Subordinal names are governed by the same rules and recommendations as ordinal names except that they end in -ineae rather than -ales. They have seldom been used among yellow-green algae. Prior to establishing a separate order for the rhizopodial forms, PASCHER (1914, pp. 143, 158) grouped them as an "Abteilung" of the order Heterochloridales, which he named Rhizochloridinae, coordinate with Heterochloridinae. PASCHER also (1915, p. 491) divided the order Heterococcales into two groups (i. e., suborders): Chlorobotrydinae, comprising uninucleate forms (Chlorobotrydaceae and Chlorotheciaceae) and Sciadiinae, comprising multinucleate forms (Sciadiaceae). FRITSCH (1935, p. 470), in a continuation of his treatment (in WEST and FRITSCH 1927) whereby the monads, dendroid forms, and palmelloid forms were placed as "series" within the "group" Heterochloridales (discussed above in the section on monads), correctly termed Heterochloridales an order and converted each of the three series into suborders. Thus, Chloramoebales became Heterochlorineae, Mischococcales became Heterodendrineae, and Heterocapsales became Heterocapsineae. A fourth suborder, Heterorhizidineae, was established to embrace the rhizopodial forms. HALL (1953, p. 133), in classifying protozoa, treated the monads, rhizopodial forms, and palmelloid forms as suborders of the order Heterochlorida, naming them Euhetero-

chlorina, Rhizochlorina, and Heterocapsina, respectively. It may be noted at this point that the coccoid, filamentous, and siphonous forms of yellow-green algae have never been included in zoological treatments.

Families

Art. 18 specifies that the name of a family is formed by adding the suffix *-aceae* to the stem of a legitimate name of an included genus. A family name not based on a generic name is invalid, while one based on an illegitimate generic name is valid but illegitimate. Inasmuch as names of families are subject to the principles of typification and priority, Art. 63, covering superfluous names, applies. According to this rule, a name is illegitimate if it was applied to a taxon which included the type of an existing available name.

Most of the families that have been proposed for use among yellow-green algae present no nomenclatural problems. They will be listed without comment in the summary of names of higher taxa at the end of this paper. Some problematical family names have already been discussed in connection with ordinal names. These will be considered further at this point, along with other troublesome names not yet mentioned.

Rhizopodial Evolutionary Line

Chlorarachniaceae PASCHER (1937, pp. 239, 251)

This family was erected by PASCHER to accommodate *Chlorarachnion* GEITLER (1930a, p. 634), a genus whose assignment to the Xanthophyceae was considered not completely certain by PASCHER. Recent ultrastructural studies by HIBBERD, NORRIS and PEARSON (1977) on *C. reptans* GEITLER, the type of its genus, have revealed strong cryptophycean affinities, but a conclusive taxonomic disposition must await the results of ongoing investigations of zoospores and pigmentation.

Rhizochloridaceae PASCHER (1925, p. 26)

Rhizochloris PASCHER, the type of this family, was not formally published until 1932 (1932b, p. 312). If this were the earliest publication of the generic name, the family name would have been invalid at its inception. As pointed out in the section on ordinal names, however, *Rhizochloris* was illustrated with a few descriptive comments in a preliminary account (PASCHER 1917b, p. 31) which I consider sufficient to constitute valid publication.

Rhizogranulochloridaceae SKVORTZOV (1972, p. 5)

This family was established to accommodate two new genera, *Garciamyxa* and *Herreramyxa*. Inasmuch as the family name is not based on a generic name, it is invalid.

Rhizounochloridaceae SKVORTZOV (1972, pp. 2, 3)

This family was established to accommodate three new genera: *Lopezmyxa*, *Aldavemyxa*, and *Requejomyxa*. Inasmuch as the family name is not based on a generic name, it is invalid.

Stipitochloridaceae DEFLANDRE (1952, p. 221, "Stipitochlorididae", nomen)

DEFLANDRE intended to establish this family to accommodate *Stipitochloris*, a genus which PASCHER had in manuscript and which DEFLANDRE validated (loc. cit.). The type (and only known) species is *S. vas* (PASCHER) DEFLANDRE (*Stipitococcus vas* PASCHER 1932b, p. 317, Fig. 8). In his monograph PASCHER (1937, p. 249) stated: "Sollten spätere Untersuchungen die rhizopodiale Natur der beiden hier genannten Arten [*Stipitococcus urceolatus* W. and G. S. WEST and *S. lauterbornei* SCHMIDLE] nicht erweisen, so müßte *Stipitococcus vas* zum Vertreter einer eigenen Gattung gemacht werden (*Stipitochloris vas* PASCHER in sched.)." DEFLANDRE proceeded to remove *S. vas* to its own genus. BOURRELLY (1968, p. 166) placed *Stipitococcus* (the type of Stipitococcaceae), *Rhizolekane* (the type of Rhizolekanaceae), and *Chlorarachnion* (the type of Chlorarachniaceae) in the family Rhizochloridaceae. There appears to be no immediate need to validate Stipitochloridaceae.

Monad Evolutionary Line

Heterochloridaceae PASCHER (1925, p. 22)

This name is superfluous (and hence illegitimate in accordance with Art. 63) inasmuch as the family to which it was applied included *Chloramoeba* BOHLIN (1898), the type of Chloramoebaceae A. LUTHER (1899), as well as *Heterochloris* PASCHER (1914, p. 159). The correct name for a family with this circumscription is Chloramoebaceae, as used by PAPENFUSS (1955), SILVA (1962), and BOURRELLY (1968).

Palmelloid Evolutionary Line

Heterocapsaceae PASCHER (1912, p. 13)

This name is invalid because it is not based on the name of an included genus. (The existence of *Heterocapsa* F. STEIN (1883), a genus of dinoflagellates, is coincidental.) FOTT (1959, p. 130), without explanation, applied the name Heterogloeaceae to a taxon with the same circumscription as Heterocapsaceae. (*Heterogloea*, a member of the Heterocapsaceae, was published by PASCHER (1930c, p. 666) as a substitute for *Chlorogloea* PASCHER (1930b, p. 407), a later homonym.) Heterogloeaceae is invalid, however, as no reference was made to the PASCHER name and a Latin diagnosis was not provided. Even if Heterocapsaceae and Heterogloeaceae had been valid, they would have been superfluous (and hence illegitimate) inasmuch as their circumscription included *Chlorosaccus* A. LUTHER (1899), the type of Chlorosaccaceae BLACKMAN and TANSLEY (1902, p. 217). If *Heterogloea* and *Chlorosaccus* are placed in the same family, its correct name would be Chlorosaccaceae. BOURRELLY (1968, p. 169), however, purified the Heterogloeaceae by removing *Chlorosaccus* to the Heterococcales on the basis of the lack of contractile vacuoles in adult cells. The possibility of considering BOURRELLY's usage a new name without the onus of superfluity is precluded by the lack of a Latin diagnosis and by the use of the name only in French form (as Hétérogloeacées). It thus appears that *Heterogloea*, as treated by BOURRELLY, is a member of a family without a legitimate name. I therefore establish the family:

Heterogloeaceae FOTT ex P. C. SILVA fam. nov. Xanthophycearum.

Cellulae ovoides, ellipsoides vel globosae, a muco communi in colonias palmelloides conjunctae, chromatophora et vacuola contractilia monstrantes. Reproductio bipartitione iterata vel emissione zoosporarum effecta. Genus typificum: *Heterogloea* PASCHER.

Coccoid Evolutionary Line

Gloeobotrydaceae PASCHER ((1937/1938, pp. 320, 632)

This name is superfluous (and hence illegitimate) inasmuch as the family to which it was applied included *Chlorobotrys* BOHLIN (1901b, p. 34), the type of Chlorobotrydaceae PASCHER (1915, p. 491), in addition to *Gloeobotrys* PASCHER (1930b, p. 436). However, *Chlorobotrys regularis* (W. WEST) BOHLIN, the type of its genus, has recently been shown to be eustigmatophycean (HIBBERD 1974), so that there would seem to be a need for a xanthophycean family to accommodate *Gloeobotrys*. BOURRELLY (1968, p. 191) placed *Gloeobotrys*, along with 14 other genera of free-living coccoid colonial forms, in a single family which he incorrectly called Chlorobotrydaceae. Among included genera, in addition to *Gloeobotrys* and *Chlorobotrys*, were *Chlorosaccus* A. LUTHER (1899), which BOURRELLY transferred from the palmelloid group because of the lack of contractile vacuoles in adult cells and which is the type of Chlorosaccaceae BLACKMAN and TANSLEY (1902); *Botryochloris* PASCHER (1930b, p. 440), the type of Botryochloridaceae PASCHER (1937/1938, pp. 320, 661); *Asterogloea* PASCHER (1930b, p. 420), the type of Asterogloeaceae ETTL (1957, p. 223); and *Tetraktis* PASCHER (1937/1938, pp. 332, 676), the type of Tetraktidaceae KOMÁREK (1964, p. 9). The correct name for a family of this circumscription is thus seen to be Chlorosaccaceae. FOTT (1971, p. 122), by contrast, adopted a narrow view of Gloeobotrydaceae, including in this family only *Chlorobotrys* in addition to *Gloeobotrys*. As can be seen from the tabulation at the end of this paper, 12 legitimate family names have been applied within the coccoid evolutionary line. Any decision to establish yet another family should be preceded by careful consideration.

Although *Chlorobotrys* has the Chlorobotrydaceae to accommodate it within the Eustigmatophyceae, neither *Vischeria* PASCHER (1937/1938, pp. 328, 553), which has also been shown to be eustigmatophycean (HIBBERD and LEEDALE 1970, 1971b, 1972), nor the newly established *Pseudocharaciopsis* LEE and BOLD (1973) has been assigned to a family.

Filamentous Evolutionary Line

Aeronemataceae FOTT (1971, p. 132)

This name was introduced presumably as a replacement for the invalid Heterocloniaceae, but it was not validly published as it lacked a Latin diagnosis. (See also Heterocloniaceae.)

Heterocloniaceae PASCHER (1931, p. 324)

This name is invalid inasmuch as it is not based on the name of a genus. PASCHER listed as included genera *Heterococcus* and *Heterodendron*, both without authors.

Heterococcus had been published by CHODAT (1907), but *Heterodendron* was a manuscript name at that time, not being validly published (by STEINECKE) until 1932. In his monograph, PASCHER (1939, p. 992) removed *Heterodendron* to its own family, Heterodendraceae. Heterocloniaceae, in turn, was divided into two tribes: Heteroclonieae, comprising only *Heterococcus* (including *Monocilia* GERNECK ex WILLE 1909, p. 86); and Heteropedieae, comprising *Aeronema* SNOW (1911) and *Heteropedia* PASCHER (1939, pp. 997, 1015). Monociliaceae G. S. WEST (1916, p. 414) was used by CHRISTENSEN (1962, 1966), but this name is illegitimate since it is based on *Monocilia*, a superfluous name for *Heterococcus*. If *Heterodendron* is placed in the same family with *Aeronema* and *Heterococcus*, as BOURRELLY (1968) and FOTT (1971) have done, Heterodendraceae comes into consideration, but this name also is illegitimate inasmuch as *Heterodendron* STEINECKE is a later homonym. The use of Aeronemataceae by FOTT (1971, p. 132) in an attempt to provide this familly with a legitimate name was invalid as he failed to provide a Latin diagnosis. At this point it seems useful to establish the family:

Heterococcaceae P. C. SILVA fam. nov. Xanthophycearum.

Cellulae filamenta ramificata uni- vel pluriserialia erecta vel prostrata formantes. Reproductio zoosporis effecta. Genus typificum: *Heterococcus* R. CHODAT.

Heterodendraceae PASCHER (1939, p. 992)

This name is illegitimate because the generic name upon which it is based, *Heterodendron* STEINECKE (1932), is a later homonym. (See also Heterocloniaceae).

Heterotrichaceae PASCHER (1939, p. 916)

This name is illegitimate because the generic name upon which it is based, *Heterothrix* PASCHER (1932b, p. 344), is a later homonym. The family originally included *Neonema* PASCHER (1925, p. 112) and *Bumilleria* BORZÌ (in MARTEL 1885, p. 191) in addition to the type genus and was set apart from Tribonemataceae PASCHER (1912, p. 18, as Tribonemaceae). Most subsequent authors have united the two families under the latter name.

Monociliaceae G. S. WEST (1916, p. 414)

This name is illegitimate since it is based on *Monocilia* GERNECK ex WILLE (1909, p. 86), a superfluous name for *Heterococcus* R. CHODAT (1907). The correct name for this family is Heterococcaceae P. C. SILVA (herein).

Tribonemataceae PASCHER (1912, p. 18, as Tribonemaceae)

As originally proposed by G. S. WEST (1904, pp. 249, 253, as Tribonemaceae) this name was superfluous (and hence illegitimate) inasmuch as the family to which it was applied included *Ophiocytium* NÄGELI (1849, p. 87), the type of Ophiocytiaceae LEMMERMANN (1899, p. 26), in addition to *Tribonema* DERBÈS and SOLIER (in CASTAGNE 1851, p. 96). As circumscribed by PASCHER, however, Tribonemataceae excludes *Ophiocytium* and hence is legitimate. Tribonemataceae PASCHER is not a homonym

of Tribonemataceae G. S. WEST inasmuch as the two names are based on the same type (cf. Art. 64).

Generic Names

Most of the genera that have been established for yellow-green algae present no nomenclatural problems. Some generic names with problems have already been mentioned. These will be discussed fully in this section, along with others not yet mentioned. The genera are arranged alphabetically.

Aeronema SNOW (1911, p. 367)

When SNOW described this monotypic genus, she called the alga *Aeronema polymorpha*. Later (1912, p. 347), she offered an alleged correction: *Aeronemum polymorphum*. Neither binomial is correct: *Aeronema*, a properly formed generic name, is neuter, so that the correct name for the species is *Aeronema polymorphum*. Not all contemporary workers recognize this genus, some (e. g., BOURRELLY 1968) preferring to follow VISCHER (1936b, p. 381), who merged it into *Heterococcus* R. CHODAT (1907).

Aulakochloris PASCHER (1937/1938, pp. 136, 326, 479, 515)

The description of this genus is spread over three fascicles of PASCHER's monograph, as is the situation with many other genera proposed in this work. When the name was first described (p. 136, Fig. 107h—k on p. 134), three species were indicated but only two were named, *A. costata* PASCHER and *A. areolata* PASCHER. Later (p. 517), all three species were named, *A. reticulata* PASCHER being the third, but *A. costata* was inexplicably changed to *A. striata* PASCHER. *Aulakochloris areolata* was chosen lectotype by A. R. LOEBLICH III (1967, p. 232). The designation of *A. reticulata* as lectotype by STARMACH (1968, p. 146) is thus incorrect.

Bracchiogonium PASCHER (1938, p. 632)

When describing *Goniochloris ophiaster*, PASCHER indicated that the generic placement was provisional and that probably it was representative of its own genus, *Bracchiogonium*. This generic name, having been published in synonymy, is not valid. ETTL (1965, p. 133) recognized *Bracchiogonium* as distinct from *Goniochloris* but did not validate the generic name by providing a Latin diagnosis. BOURRELLY (1968, p. 188) merged the genus into *Tetraplektron* FOTT (1957). If *Bracchiogonium* is to be recognized, as by STARMACH (1968, p. 184), the name must be validated by the provision of a Latin diagnosis.

Brachynema ÅLVIK (1934, p. 35)

This poorly known genus, comprising the single species *B. bacillare* ÅLVIK (1934, p. 36, pl. II: Figs. 5—14), resides insecurely in the Tribonemataceae. The generic name is a later homonym of *Brachynema* BENTHAM (Trans. Linn. Soc. London 22: 126. 1857), a nomen conservandum in the Ebenaceae. As a substitute I propose *Brachynematella*, with the type species *B. bacillaris* (ÅLVIK) comb. nov.

The name *Brachynema* has been applied to another genus of algae: *Brachynema* ERCEGOVIĆ (1931, p. 35) in the Chamaesiphonales (Cyanophyceae), renamed *Ercegovicia* by GIUSEPPE DE TONI (1936).

Bumilleria BORZÌ (1889, p. 69; in DE TONI 1889, p. 586)

BORZÌ is usually considered to have first published this genus validly in 1895. However, he originally called it *Hormotheca*, and in a key to the genera of the Sciadiaceae (in MARTEL 1885) this name was validated by a brief characterization. No species were cited. In 1889 BORZÌ proposed the name *Bumilleria* and cited *Hormotheca* BORZÌ in synonymy, presumably having become aware of the existence of an earlier use of the name *Hormotheca*, that by BONORDEN (Abh. Naturf. Ges. Halle 8: 149. 1864), who applied it to a genus of Pyrenomycetes. At nearly the same time (and perhaps even earlier) DE TONI (1889, p. 586), in the first volume of his "Sylloge Algarum", listed *Bumilleria* BORZÌ with a reference to *Hormotheca* BORZÌ 1885 non BONORDEN. DE TONI's book was published July 25, 1889, while BORZÌ's article was written in June of the same year. Whichever is the earlier of the two references is the first valid publication of *Bumilleria*. The name had appeared previously, however, in DE TONI's synopsis of his "Sylloge Algarum" (1888, p. 451), but without a description and without reference to *Hormotheca*.

It should be noted that up to this time (1889) no species had been indicated for the genus. WILLE (1890, p. 85, Fig. 49) was the first to establish species within *Bumilleria*. His Fig. 49 was supplied by BORZÌ from manuscript and illustrates the single species of the genus, which WILLE named *B. borziana*. BORZÌ (1895, p. 185) finally published a detailed description of the genus, with full reference to *Hormotheca* BORZÌ, naming the single species *B. sicula*, an obligate synonym of *B. borziana* WILLE 1890.

In summary, *Bumilleria* BORZÌ dates from 1889 and its type species should be called *B. borziana* WILLE (1890) rather than *B. sicula* BORZÌ (1895), contrary to universal usage.

Characidiopsis PASCHER (1937/1938, pp. 329, 330, 718, 719)

This genus originally comprised three species, of which *C. acuta* PASCHER was chosen lectotype by A. R. LOEBLICH III (1967, p. 232). The designation of *C. elongata* PASCHER as lectotype by STARMACH (1968, p. 69) is thus incorrect.

Characiopsis BORZÌ (1895, p. 151)

According to card 63/15529 of the Index Nominum Genericorum, this generic name was untypified, and accordingly a lectotype was chosen by A. R. LOEBLICH III (1967, p. 232), who selected *C.* ? *pyriformis* (BRAUN) BORZÌ (*Characium pyriforme* BRAUN). It should be noted, however, that BORZÌ originally (p. 154) indicated *Characium minutum* BRAUN as holotype. Therein lies a problem. LEMMERMANN (1914, p. 256), after studying the type specimen of *Characium minutum* in the Berlin Herbarium and comparing it with BORZÌ's description and figures of *Characiopsis minuta* (BRAUN) BORZÌ, decided that two species were involved. LEMMERMANN named the one that

BORZÌ had in hand *C. borziana*. In my opinion a genus should be typified with material at hand, whether or not the author misidentified the type with a previously described species. Accordingly, I consider *C. borziana* the type of its genus.

Chlorallantus PASCHER (1930b, p. 421: "*Chlorallanthus*")

PASCHER originally spelled this generic name *Chlorallanthus*, without giving its derivation. In the introductory portion of his monograph he used that spelling once more (1937, p. 179), but in the formal systematic treatment (1937, pp. 326, 479; 1938, p. 519) he spelled the name *Chlorallantus* and provided the etymology, "(χλωρός = grün; ἡ ἀλλᾶς, -αντός = die Wurst)". In my opinion *Chlorallantus* may be considered a correction of an orthographic error in accordance with Art. 73 of the IBCN and dated from 1930, with the single original species, *C. oblongus* PASCHER, as type. Many present-day experts in botanical nomenclature would interpret Art. 73 more strictly, however, maintaining that *Chlorallantus* could be adopted in preference to *Chlorallanthus* only by conserving the altered spelling.

Chlorapion BOURRELLY (1959, p. 172)

This generic name, previously treated as feminine or masculine (the only epithet that has been used, *grandis*, not differentiating between the two genders), is neuter (χλωρός, green; το ἀπιον, pear). The type (and only known species) should thus be called *C. grande* (DÜRINGER) BOURRELLY. *Chlorapion* is a substitute name for *Apiochloris* DÜRINGER (1958, p. 38), a later homonym of *Apiochloris* PASCHER (1930a, p. 105) in the Polyblepharidaceae.

Chlorellidium VISCHER (1936a, p. 307)

This genus is usually attributed to PASCHER and VISCHER, as published in an article by VISCHER (1937, pp. 241, 249). It was proposed in a preliminary manner, however, during the previous year by VISCHER (1936a, p. 307), who did not make the authorship clear. The characterization is extremely brief, but in my opinion sufficient to constitute valid publication. No species were named. The generic name next appeared in Lieferung 2 of PASCHER's monograph (1937), in a chapter by VISCHER on the culture of heterokonts. In a table on p. 201 *Chlorellidium tetrabotrys* VISCHER and PASCHER is listed, with the citation of two VISCHER cultures in Basel. The main entry for *Chlorellidium* in PASCHER's monograph is on p. 668 (Lieferung 5, 1938), where the genus is attributed to VISCHER and PASCHER (the reverse order of authors compared to that given in VISCHER's 1937 paper). In my opinion the generic name should be attributed solely to VISCHER, dating from 1936, with the type species attributed to VISCHER and PASCHER, dating from Lieferung 2 of PASCHER's monograph (1937). Whether the authorship of the genus should be cited as VISCHER, PASCHER and VISCHER in VISCHER, or VISCHER and PASCHER in PASCHER is inconsequential to the organism and to our study of the organism, yet in the same manner that routine handling of personal maintenance frees one's mind for creative thinking, so uniformity in "housekeeping" aspects of science allows greater effort to be expended in productive pursuits. Stated in another way, lack of uniformity in such

trivial, yet necessary matters as citation of authors, places and dates of publication, and orthography of names draws attention, time, and energy away from important issues. Regrettably, phycologists have shown a rare ability to create hopelessly complex bibliographic and nomenclatural situations.

Chloridella PASCHER (1932b, p. 336)

This genus originally included two species, *C. neglecta* PASCHER and *C. major* PASCHER. In his systematic lectotypification of xanthophycean genera, A. R. LOEBLICH III (1967) overlooked *Chloridella*. STARMACH (1968, p. 86) chose *C. neglecta* as lectotype.

Diachros PASCHER (1937, pp. 324, 334, 370)

This genus originally included three species, of which *D. pleiochloris* PASCHER was chosen lectotype by A. R. LOEBLICH III (1967, p. 233). The indication of *D. simplex* PASCHER as lectotype by STARMACH (1968, p. 89) is thus incorrect.

Dioxys PASCHER (1932c, p. 564)

This genus originally included two species, of which *D. rectus* PASCHER was chosen lectotype by A. R. LOEBLICH III (1967, p. 233). The indication of *D. incus* PASCHER as lectotype by STARMACH (1968, p. 265) is thus incorrect.

Ellipsoidion PASCHER (1937, pp. 326, 407, 408)

This genus originally included nine species, of which *E. anulatum* PASCHER was chosen lectotype by A. R. LOEBLICH III (1967, p. 233). The indication of *E. solitare* PASCHER as lectotype by STARMACH (1968, p. 99) is thus incorrect.

Endochloridion PASCHER (1930b, p. 415)

This genus originally included two species, of which *E. polychloron* PASCHER was chosen lectotype by A. R. LOEBLICH III (1967, p. 233). The indication of *E. simplex* PASCHER as lectotype by STARMACH (1968, p. 133) is thus incorrect.

Fremya P. A. DANGEARD (1934, p. 674)

This interesting but poorly known organism was discussed in connection with *Myxochloris* (Rhizocloridales) by PASCHER (1937, p. 273), who declined to assign it a definite taxonomic position. It comprises the single species *F. sphagni* P. A. DANGEARD (1934, p. 674, pl. LV). BOURRELLY (1968, p. 224) placed it in the Heterotrichales near *Heterococcus*. The generic name is a later homonym of *Fremya* BRONGNIART and GRIS (Bull. Soc. Bot. France 10: 372. 1863) in the Myrtaceae. As a substitute I propose *Sphagnoikos*, with the type species *S. sphagni* (P. A. DANGEARD) comb. nov.

Gloeobotrys PASCHER (1930b, p. 436)

PASCHER originally treated this generic name as feminine, but later (1938, p. 633) he correctly gave the gender as masculine (γλοιός, sticky; ὁ βότρυς, bunch of grapes). Of the two species originally included in the genus, *G. mucosus* PASCHER and CZURDA was placed there with uncertainty, leaving *G. chlorinus* to serve as type. In his monograph, PASCHER (1938, pp. 636—637) stated that *G. mucosus* was a chrysophyte.

Heterocalyx BURSA (1954, p. 11)

This genus, with the single species *H. levantinoides* BURSA (loc. cit.), was established for an organism living epiphytically on the marine diatom *Licmophora* at Bat Yam, Israel. BURSA evidently created for it a new family, Heterorhizidaceae, which he failed to characterize, however. The generic name is a later homonym of *Heterocalyx* SAPORTA (Ann. Sc. Nat. Bot. ser. 5. 18: 110. 1873), applied to a genus of fossil Anacardiaceae. As a substitute I propose *Heterocalycina*, with the type species *H. levantinoides* (BURSA) comb. nov.

The euphorbiaceous genus *Heterocalyx* GAGNEPAIN [Not. Syst. (Mus. Natl. Hist. Nat. Paris) 14: 33. 1950] if accepted must be renamed.

Heterococcus R. CHODAT (1907, p. 81)

At the outset it should be noted that although this genus is usually cited as having been published in 1908, the fascicle of the journal in which it appeared is clearly stated to have been issued Dec. 28, 1907. When establishing the genus, CHODAT indicated the possibility, but uncertainty, that his material was conspecific with *Monocilia viridis* GERNECK (1907, p. 263, pl. XII: figs. 77—84). GERNECK had described simultaneously a second new species, *M. flavescens*, but without characterizing the genus. CHODAT correctly considered *Monocilia* a nomen nudum. In view of this fact, the question whether CHODAT's *Heterococcus viridis* should be treated as a new combination or a new species is obviated: it can be treated only as a new species.

Monocilia was first given a description (and hence validated) by WILLE (1909, p. 86). Believing that the genus had been properly published by GERNECK, WILLE cited *Heterococcus* in synonymy. Two species were included by WILLE, *M. flavescens* and *M. viridis*. There is no doubt that the first species should be accredited to GERNECK ex WILLE. The second species, however, which WILLE accredited to GERNECK, citing *Heterococcus viridis* CHODAT in synonymy, is open to two interpretations. One could consider WILLE's role as reportorial, that he merely validated GERNECK's *M. viridis* in the same way that he did *M. flavescens*, and that the citation of *Heterococcus viridis* CHODAT as a synonym was a taxonomic statement not accompanied by nomenclatural action. On the other hand, one could consider *M. viridis* a new combination, effectively if not intentionally so. I prefer the former interpretation, citing the species *M. viridis* GERNECK ex WILLE.

Heterococcus viridis and *Monocilia viridis* were considered congeneric, but not conspecific, by VISCHER (1936b, p. 391), who incorrectly proposed for CHODAT's species the name *Heterococcus chodatii* (as *chodati*). He considered *Monocilia viridis* an incompletely known species of *Heterococcus*, for which he declined to use the epithet *viridis*, calling it merely *H. spec.* The incorrect usage of *H. chodatii* has unfortunately been continued by PITSCHMANN in his excellent monograph of the genus (1963, p. 493), by BOURRELLY (1968, pl. 45: fig. 3), and by FOTT (1971, p. 133). If two species are indeed involved, GERNECK's is the one that must be renamed.

Heterodendron STEINECKE (1932, p. 592)

This genus was established for *H. pascheri* STEINECKE. A second species, *H. squarrosum*, was added by PASCHER (1932b, p. 358, figs. 36, 37), who later (1939, p. 992) established the family Heterodendraceae within the Heterocloniales. In the opinion of ETTL (1959), however, *Heterodendron* is not a yellow-green alga, but rather a growth phase of *Phaeothamnion* LAGERHEIM (1884) in the Chrysophyceae. The possibility of such an interpretation was raised by PASCHER (1939, p. 993). The two genera differ apparently only in the color of the chloroplasts. ETTL observed both yellow and yellow-green chloroplasts in the same material, and in view of the fact that in many Chrysophyceae the chloroplasts are yellow or yellow-green rather than yellow-brown, he concluded that the two genera were synonymous. BOURRELLY (1968, p. 223) cited ETTL's work, but nonetheless retained *Heterodendron* and Heterodendraceae. If retained, *Heterodendron* STEINECKE must be renamed inasmuch as it is a later homonym of *Heterodendrum* DESFONTAINES [Mém. Mus. Hist. Nat. (Paris) 4: 8. 1818, orth. mut. *Heterodendron* C. SPRENGEL, Syst. Veg. 2: 356. 1825] in the Sapindaceae.

Heteropedia PASCHER (1939, pp. 997, 1015).

Like most generic names proposed in PASCHER's monograph, *Heteropedia* was introduced several times in the general part (pp. 1—202) issued in 1937, and not merely as a nomen. If all the fragments of information were brought together and analyzed, a case for recognition of valid publication might result. PASCHER's monograph, despite its consummate usefulness and scholarship, is a bibliographic headache. In several instances PASCHER changed his mind between the time he wrote the general part and the time he wrote the systematic account. For example, *Excentrochloris irregularis* illustrated in Fig. 86a, b on p. 99 (Lief. 1) was formally published as *E. gigas* on p. 400 (Lief. 3), with the figures reappearing as Fig. 268b, c on p. 397. Moreover, many generic names are validated in keys published earlier than the formal entry, sometimes in a preceding year.

Heteropedia originally included two species (and no more have been added): *H. simplex* (PASCHER) PASCHER (*Monocilia simplex* PASCHER, 1932b, p. 355, figs. 33, 34) and *H. polychloris* PASCHER. STARMACH (1968, p. 356) selected *H. simplex* as lectotype, a logical choice since PASCHER clearly based his generic concept largely on this species.

Heterothrix PASCHER (1932b, p. 344)

This genus originally included two species: *H. exilis* (KLEBS) PASCHER (*Bumilleria exilis* KLEBS 1896, p. 389, pl. II: Figs. 15—20) and *H. ulotrichoides* PASCHER. Although the generic concept was obviously based largely if not entirely on *H. exilis*, this species was not explicitly designated the type. FRITSCH's statement (1951, p. 86) that *Heterothrix* was "based on the *Bumilleria exilis* of KLEBS" is effectively a lectotypification. *Heterothrix exilis* is incorrectly listed as type rather than lectotype on card 63/18050 of the Index Nominum Genericorum.

A third species was described by VISCHER in 1936, four more were added by PASCHER in his monograph, and eight more by various authors since 1945. *Heterothrix* PASCHER is a later homonym of *Heterothrix* JEAN MÜLLER (in MARTIUS, Fl. Bras.

6 (1): 133. 1860) in the Apocynaceae. As a substitute I propose *Xanthonema*, with the type species *X. exile* (KLEBS) comb. nov. The other species are as follows:

X. bristolianum (PASCHER) comb. nov. (*Heterothrix bristoliana* PASCHER 1939, pp. 920, 924, Fig. 778)
X. constrictum (ETTL) comb. nov. (*Heterothrix constricta* ETTL 1965, p. 138, pl. 36 (7): Figs. 11—14).
X. debile (VISCHER) comb. nov. (*Heterothrix debilis* VISCHER 1936b, p. 379: Figs. 2, 3)
X. elegans (ETTL) comb. nov. (*Heterothrix elegans* ETTL 1956, p. 442, Fig. 18)
X. hormidioides (VISCHER) comb. nov. (*Heterothrix hormidioides* VISCHER 1945, p. 499, pl. 1:Fig. 6; Abb. 14)
X. monochloron (ETTL) comb. nov. (*Heterothrix monochloron* ETTL 1956, p. 439, Fig. 15)
X. montanum (VISCHER) comb. nov. (*Heterothrix montana* VISCHER 1945, p. 496, Abb. 12A, 12B a—c)
X. oligochloris (ETTL) comb. nov. (*Heterothrix oligochloris* ETTL 1965, p. 139, pl. 36 (7): Figs. 15 to 20)
X. pascheri (ETTL) comb. nov. (*Heterothrix pascheri* ETTL 1956, p. 441, Fig. 17)
X. quadratum (PASCHER) comb. nov. (*Tribonema quadratum* PASCHER 1925, p. 107, Fig. 88b)
X. solidum (VISCHER) comb. nov. (*Heterothrix solida* VISCHER 1945, p. 498, pl. 1: Fig. 5; Abb. 13)
X. stichococcoides (PASCHER) comb. nov. (*Heterothrix stichococcoides* PASCHER 1939, pp. 919, 920, Fig. 773)
X. tribonematoides (PASCHER) comb. nov. (*Heterothrix tribonematoides* PASCHER 1939, pp. 920, 927, Figs. 779, 781a, b)
X. ulotrichoides (PASCHER) comb. nov. (*Heterothrix ulotrichoides* PASCHER 1932b, p. 345, Fig. 22b).

Heterothrix fluviatilis GAYRAL and MAZANCOURT (1959, p. 349, Fig. II: 5) lacked a Latin diagnosis and hence was not validly published.

Heterothrix (B. L. ROBINSON) RYDBERG (Bull. Torrey Bot. Club 34: 435. 1907) in the Cruciferae was renamed *Pennellia* by NIEUWLAND (Amer. Midl. Nat. 5: 224. 1918).

Ilsteria SKUJA and PASCHER (in PASCHER 1937/1938, pp. 332, 671)

Four species were originally included in this genus, without an indication of type. *Ilsteria quadrijuncta* SKUJA (in PASCHER 1938, pp. 673, 675, Fig. 530) is incorrectly listed as type rather than lectotype on card 63/18060 of the Index Nominum Genericorum issued February 1964. This card itself is the place of lectotypification. The choice is logical from the historical point of view: *Ilsteria* apparently was conceived by SKUJA on the basis of *I. quadrijuncta*, SKUJA then joining PASCHER (who had in hand other species of the genus) in proposing the new genus.

Isthmochloron SKUJA (1948, p. 334)

This genus originally comprised two species: *I. lobulatum* (NÄGELI) SKUJA (*Polyedrium lobulatum* NÄGELI) and *I. trispinatum* (W. and G. S. WEST) SKUJA (*Ankistrodesmus trispinatus* W. and G. S. WEST). BOURRELLY (1952, p. 667) lectotypified it with *I. lobulatum*, expressing the opinion (p. 671) that *I. trispinatum* represents a member of the Dinococcales or a peridinian cyst. A. R. LOEBLICH III (1967, p. 233), in a superfluous action, also designated *I. lobulatum* as lectotype.

Isthmochloron was merged with *Pseudostaurastrum* (HANSGIRG) R. CHODAT (1921, p. 304) by FOTT and KOMÁREK (1960, p. 121). This treatment was followed by BOURRELLY (1968, p. 190).

Meringosphaera LOHMANN (1902, p. 68)

This genus originally comprised four new species of marine plankton (*M. baltica*, *M. divergens*, *M. hydroidea*, and *M. mediterranea*) representing spherical or ellipsoidal setiferous organisms. The cells observed by LOHMANN were said to be green, but a similar form, previously figured but not named, had been said by its observer to be yellow (HENSEN 1887, pl. V: Fig. 55). LOHMANN added two more species to the genus in 1908 (p. 256ff.), *M. radians* and *M. serrata*, both described as green. At the same time, he reduced *M. baltica* to synonymy under *M. mediterranea*. LOHMANN later (1913, p. 151) transferred *M. hydroidea* into *Ophiaster* GRAN, a genus of coccolithophorids.

Five more species were described, from the Adriatic, by SCHILLER: *M. hensenii* (as *henseni*; yellowish green) and *M. triseta* (dark green when living, becoming yellowish green after death) (1916a, p. 204ff.); *M. merzii* (as *merzi*; yellow-green), *M. setifera* (yellow-green), and *M. tenerrima* (yellow-green) (1925, p. 77ff.). Four species were contributed by PASCHER: *M. aculeata*, *M. brevispina*, and *M. sol* (1932a, p. 202ff., without indication of color); *M. wulffiana* (almost colorless; 1938, p. 539). All of these species are marine, but PRESCOTT (in PRESCOTT, H. SILVA and WADE 1949, p. 87) described *M. spinosa* from an acid pond in Michigan. There can be no doubt, merely from a comparison of figures, that *Meringosphaera* has been used as a catch-all for widely varying organisms.

PASCHER (1932a, p. 201) was keenly aware of the heterogeneity among the various species that had been assigned to *Meringosphaera* and proposed to subdivide the genus into three subgenera. Subg. *Eumeringosphaera*, with the setae distributed over the surface of the cell, was further divided into sect. *Raphidosphaera*, with straight needle-shaped setae, and sect. *Kymatosphaera*, with thicker wavy processes. Subg. *Skiadosphaera* was established to receive those species with polar setae, while subg. *Radiosphaera* received those species with equatorial setae. Two species were excluded from the genus: *M. radians*, which, as PASCHER pointed out, differs markedly from all other species that have been placed in the genus by (1) the motility of its processes, which originate deep within the protoplast rather than from the wall, (2) the regularly alternating position of processes and chloroplasts, and (3) the thick lump-like chloroplasts contrasted with the thin plate-like structures in the other species; and *M. serrata*, which PASCHER thought might be a coccolithophorid.

The critical question at this point in the present account is the following: to which single species or group of species should the name *Meringosphaera* be applied? Inasmuch as LOHMANN did not designate a type, we must examine the literature to determine the earliest lectotypification. WILLE (1909, p. 58) effectively lectotypified the genus by restricting it to three species, only one of which, *M. mediterranea*, was originally placed there by LOHMANN. *Meringosphaera baltica* was included within the circumscription of *M. mediterranea*, a treatment first suggested by LOHMANN himself (1908, p. 256). PASCHER (1932a) confirmed this lectotypification, again treating *M. baltica* as a synonym of *M. mediterranea* within the subg. *Eumeringosphaera*, assigning *M. divergens* to his new subgenus *Skiadosphaera*, and explicitly removing *M. hydro-*

idea to the coccolithophorids in accordance with LOHMANN's opinion (1913, p. 151). The lectotypification of *Meringosphaera* with *M. mediterranea* was formalized by A. R. LOEBLICH, Jr. and TAPPAN (1963, p. 193). Thus, *Meringosphaera* by definition must be applied to *M. mediterranea* and to all other species considered congeneric with *M. mediterranea.*

In his monograph, *Pascher* elevated *Meringosphaera* subg. *Skiadosphaera* and subg. *Radiosphaera* both to generic rank. *Meringosphaera* was divided into two subgenera: *Meringosphaera* (= subg. *Eumeringosphaera* sect. *Kymatosphaera* of PASCHER's 1932 treatment) and *Raphidosphaera* (subg. *Eumeringosphaera* sect. *Raphidosphaera* of his 1932 treatment). These two subgenera encompass two widely divergent groups of species. Of subg. *Raphidosphaera*, PASCHER stated (1938, p. 539): „Die Untergattung wird bei eingehendem Studium der meringosphaeriden Heterococcalen des Meeres sicher als eigene Gattung behandelt werden müssen. Beziehungen zur Artenreihe mit gewellten Borsten, die nicht nadelförmig verjüngt sind, kaum wahrscheinlich." I believe that the elevation of this subgenus to generic rank will help isolate the problem of the identity of *Meringosphaera.*

Raphidosphaera (PASCHER) P. C. SILVA, stat. nov. *Meringosphaera* subg. *Eumeringosphaera* sect. *Raphidosphaera* PASCHER (1932a, p. 202). Type species (designated herein): *R. tenerrima* (SCHILLER) comb. nov. (*M. tenerrima* SCHILLER 1925, p. 77, pl. 3: Fig. 2).

Other species: *R. brevispina* (PASCHER) comb. nov. (*Meringosphaera brevispina* PASCHER 1932a, p. 202, Fig. 3); *R. setifera* (SCHILLER) comb. nov. (*Meringosphaera setifera* SCHILLER 1925, p. 79, Text-Fig. M); and *R. wulffiana* (PASCHER) comb. nov. (*Meringosphaera wulffiana* PASCHER 1938, pp. 538, 539, Figs. 390, 391).

The four species remaining in *Meringosphaera* subg. *Meringosphaera* also display heterogeneity: *M. merzii* and *M. hensenii* appear to be closely related to one another (cf. NORRIS 1971, p. 911), but probably sufficiently distinct from *M. mediterranea* and *M. aculeata* to be recognized as a separate genus. The various forms that have been attributed to *M. mediterranea* are in themselves heterogeneous and undoubtedly represent more than one species, possibly more than one genus.

In the absence of a definition of the genus *Meringosphaera*, it is of course impossible to assign it a systematic position. LOHMANN considered his original four species as representing "Protophyten unsicherer Stellung", but their superficial resemblance to *Micractinium* and *Oocystis* and their green chloroplasts led to their alignment in the chlorococcalean family Oocystaceae (WILLE 1909, p. 58). PASCHER (1912, p. 16) expressed doubt that *Meringosphaera* was properly placed among the green algae and suggested alignment with the Chlorobotrydaceae in the yellow-green algae, but without offering reasons for doing so. SCHILLER (1916a, pp. 202—203) revealed some important information regarding an organism that he identified as *M. mediterranea.* He demonstrated that the wall and setae were lightly silicified and that the food storage product was oil. He confirmed the fact that the chloroplasts were green. PASCHER (1917, p. 170) observed endogenous cysts with siliceous sculptured two-

piece walls in *M. triseta* and in an undetermined species of the genus, which he thus assigned to the Heterococcales among the yellow-green algae without doubt. Recently, NORRIS (1971, p. 911), after having observed living cells "with a distinct golden tinge" in collections from the Indian Ocean, concluded that *Meringosphaera* should be placed in the Aurosphaeraceae of the Chrysophyceae. PASCHER (1917, p. 174) had previously commented on the similarity of *Meringosphaera* and *Aurosphaera* SCHILLER (1916b, p. 303), emphasizing that the high degree of variability in the carotenoid content of xanthophycean chloroplasts might bridge the gap between the green *Meringosphaera* and the yellow *Aurosphaera*, which he thought might also be a heterokont.

While it may well be that *M. mediterranea* (and hence by definition the genus *Meringosphaera*) is really a chrysophyte, in my opinion this fact remains to be demonstrated. Biochemical, ultrastructural, and life-history cultural studies must be made on organisms from the Mediterranean which show reasonable agreement with LOHMANN's account of *M. mediterranea*. At the present time there are very few characters that can be assigned this species with any degree of certainty. Information about other species, while important in itself, is immaterial in ascertaining the correct application of the name *Meringosphaera* and the taxonomic placement of the genus to which that name applies. In any event, it seems likely that the *Meringosphaera* complex encompasses members of both Chrysphyceae and Xanthophyceae.

Monallantus PASCHER (1937, pp. 326 = key, 407 = key: "*Monallanthus*", 420)

In accordance with the etymology provided by PASCHER, "(*μόνος* = allein, *ὁ ἀλλᾶς*, *-αντός* = die [Knoblauch]-Wurst", the correct spelling of this generic name is *Monallantus*, but PASCHER used the spelling *Monallanthus* in several places in his monograph, especially in the introductory portion (Lief. 1, p. 92 adnot. = legend to Fig. 77 *1*, p. 94, p. 103, Fig. 90 *h*; Lief. 2, p. 179; Lief. 3, p. 407). As in the case of *Chlorallantus*, discussed previously, I would consider *Monallanthus* correctable to *Monallantus* in accordance with Art. 73 of the ICBN. The situation is not unequivocal, however, because the information given for this genus by PASCHER in the introductory portion is probably sufficient to validate the name prior to the formal proposal in the systematic section. Inasmuch as some statements were referred to *Monallanthus* and others to *Monallantus*, those nomenclaturalists who would uphold the original spelling face a difficult task in deciding which of the two spellings has priority.

Of the four species originally included in the genus, *M. brevicylindrus* PASCHER was designated lectotype by A. R. LOEBLICH III (1967, p. 234).

Monodus R. CHODAT (1913, p. 185)

This genus was established to accommodate a new species of free-living unicellular algae, *M. ovalis* R. CHODAT, that appeared in a culture. A second species was also included — *M. acuminatus* (GERNECK) R. CHODAT (*Chlorella acuminata* GERNECK 1907, p. 249), which CHODAT thought differed from *M. ovalis* chiefly in its dimensions. Since the generic diagnosis was based entirely on *M. ovalis*, that species must be considered

the holotype of the genus. When it was discovered that *M. ovalis* grew attached to filamentous algae and other aquatic organisms, CHODAT (in POULTON 1925, p. 32) transferred it into *Characiopsis*, without indicating the fate of *M. acuminatus*. PRINTZ (1927, p. 393) followed CHODAT in referring *M. ovalis* to *Characiopsis*, but continued to recognize *Monodus*, accrediting it to CHODAT and giving a description which did not differ materially from the original diagnosis. PRINTZ included three species in his treatment of *Monodus: M. acuminatus*, *M. amicimei* PASCHER (1915, p. 492), and *M. chodatii* PASCHER (1925, p. 52, "*chodati*"). In PRINTZ's words, „Übrigens ist die ganze Gattung recht problematisch." In his monograph, PASCHER (1937, pp. 436—437) gave a lengthy discussion of the biological validity of the genus, based upon the erroneous premise that it was established by CHODAT for *M. acuminatus*. He stressed the need for culture studies to determine whether certain forms assigned to *Monodus* were stages in the life histories of other algae and whether *M. ovalis* was truly a *Characiopsis*. He included 12 species in the genus. If the genus is to be retained, as it has been by all present-day workers (e. g., FOTT 1959, 1971; REISIGL 1964; ETTL 1965; BOURRELLY 1968), either the name *Monodus* must be conserved with an altered type (i. e., *M. acuminatus* rather than *M. ovalis*) or the genus must be described anew. Considering the fact that the original diagnosis of *Monodus* fits *M. acuminatus*, lacking any reference to an attachment structure, it seems reasonable to retain that generic name, accredited to CHODAT (1913), with *M. acuminatus* as type. A formal proposal for conservation will be made elsewhere.

CHODAT correctly treated the name *Monodus* as masculine, but PRINTZ (1927, p. 393) treated it as feminine (probably inadvertently). PASCHER (1937, p. 435) also treated it as feminine, giving the allegedly supporting etymology "*μόνος* einzeln, *ἡ ὀδοῦς* der Zahn". PASCHER notwithstanding, the gender of *ὀδοῦς* (and hence *Monodus*) is masculine.

Neonema PASCHER (1925, p. 112)

After concluding his treatment of *Bumilleria*, PASCHER set the stage for proposing *Neonema* with the following words: „Ich gebe hier Figur und Beschreibung einer Alge wieder, die bereits von WEST in seinem Treatise abgebildet ist und von ihm zu Unrecht als *Bumilleria* angesprochen und behandelt wird. Sie gehört gewiss nicht zu *Bumilleria*." There followed a description, lacking dimensions, accompanied by Fig. 91, about which PASCHER stated: „Ich gebe Figuren [there is only one figure] nach Material aus Stuben am Arlberg, nach dem Leben gezeichnet." This genus differs from *Bumilleria* in the formation of mucilaginous sheaths around the filaments, thus paralleling *Geminella* in the Ulotrichaceae (green algae). PASCHER concluded: „Mir scheint es, als läge eine eigene Gattung vor, die die bei *Tribonema* und *Bumilleria* nur sehr seltene Scheidenbildung gewissermassen zur Regel gemacht hat, und ich trug sie auch in meinen Notizen als *Neonema quadratum* ein (Fig. 91)." As localities PASCHER cited Scotland, the Voralps (Tirol), and Bohemia.

By referring to WEST's "Treatise on British Freshwater Algae" and comparing figures, one might conclude that *Neonema quadratum* is illegitimate, PASCHER having

been obligated to adopt the epithet *pumila* (from *Bumilleria pumila* W. and G. S. WEST 1903, p. 77, pl. 446: Figs. 22, 23). Another interpretation seems acceptable, however: that when PASCHER said that this alga had already been figured by WEST he meant a representative of the genus, not necessarily PASCHER's species. This interpretation is borne out in a later paper by PASCHER (1932b, p. 348), who explained that he had applied the name *Neonema quadratum* to his material from Arlberg because it did not agree fully in its dimensions with the WEST's material from Cornwall (PASCHER's citation of Scotland in his original account was obviously an error). In this second paper PASCHER had second thoughts about the conspecificity of his material and that of the WESTS, and in the absence of convincing evidence one way or the other, he decided to adopt the epithet *pumila* and abandon the name *N. quadratum*. He published several more figures, all presumably based on new material from Lindau im Bodensee (Bayern). Finally, in his monograph, PASCHER (1939, p. 932) returned to his original opinion and clearly recognized two species, differing only in cell dimensions: *N. pumilum* was said to have cells 4.8—5.7 μm broad, 5—6 μm long (exactly the dimensions given by the WESTS) and to be known only from Cornwall. *Neonema quadratum* was said to have isodiametric cells 8—11 μm across and to be known from the Arlberg and from the High Tatra Mountains (material from the latter locality provided by FOTT and illustrated as Fig. 783). Curiously, no mention was made of Lindau im Bodensee. PASCHER stated that the generic description of swarmers, palmellae, and akinetes was drawn from *N. quadratum*. The literature citations for the two species are hopelessly confusing. PASCHER cited Fig. 91 from his 1925 work under *N. pumilum*, yet as I have just pointed out, he stated in 1925 that Fig. 91 was based on original material from Arlberg. It is possible that Fig. 91 was indeed merely a redrawing of the figure in WEST's "Treatise". Regardless of the identity of Fig. 91, in my opinion the type species of *Neonema* should be cited *N. quadratum* PASCHER, with the type material from the Arlberg. It should not be considered a superfluous name for *N. pumilum* (W. and G. S. WEST) PASCHER.

Nephrodiella PASCHER (1937, pp. 326, 428)

This genus, which PASCHER assigned to the Pleurochloridaceae, originally comprised five newly described species: *N. acuta*, *N. lunaris*, *N. minor*, *N. phaseolus*, and *N. semilunaris*. STARMACH (1968, p. 107) designated *N. phaseolus* PASCHER (1937, p. 429, Figs. 295, 296) as lectotype.

Pseudostaurastrum (HANSGIRG) R. CHODAT (1921, p. 304)

This genus of Pleurochloridaceae was initiated as a section of *Tetraedron* KÜTZING (1845, p. 129) by HANSGIRG (1888, p. 132), who included in it *T. enorme* (RALFS) HANSGIRG (*Staurastrum enorme* RALFS), *T. lobulatum* (NÄGELI) HANSGIRG (*Polyedrium lobulatum* NÄGELI), and *T. hastatum* (REINSCH) HANSGIRG (*Polyedrium lobulatum* f. *hastatum* REINSCH). In a later work, HANSGIRG (1892, p. 232) cited only one species in this section, *T. lobulatum*, but this should not be considered a lectotypification as this work is floristic rather than monographic and it is likely that the other two species were not known to HANSGIRG from his area (Bohemia). *Tetraedron* sect.

Pseudostaurastrum was raised to generic rank by CHODAT (1921, p. 304), who, however, referred back only as far as HANSGIRG's "Prodromus" (1892), which led him to make the erroneous statement that *T. lobulatum* was the species that HANSGIRG took as type of the section. CHODAT recognized a single polymorphic species, encompassing several previously described species, to which he correctly applied the name *Pseudostaurastrum enorme* (RALFS) R. CHODAT, adopting the earliest available epithet (*Staurastrum enorme* RALFS 1848) among the several species. Although saying that it is very doubtful that each of these forms really represents a distinct species and that it is better to describe them as states of a single species, CHODAT nonetheless proceeded to make combinations for these variants within the genus *Pseudostaurastrum*. These five combinations, being made in synonymy, are invalid.

BOURRELLY (1952, p. 667) adopted *Pseudostaurastrum* in a greatly expanded sense, to encompass five previously described genera which he treated as sections: *Tetraedriella* PASCHER (1930b, p. 423), *Tetrakentron* PASCHER (1937/1938, pp. 328, 595), *Tetragoniella* PASCHER (1930b, p. 426), *Goniochloris* GEITLER (1928, p. 81), and *Isthmochloron* SKUJA (1948, p. 334). CHODAT's original concept of *Pseudostaurastrum* was contained in sect. *Isthmochloron*, although Bourrelly inexplicably omitted *P. enorme* in his synopsis of the genus.

FOTT and KOMÁREK (1960, p. 121) were of the opinion that the uniting of these genera was nonproductive and chose to treat these closely related groups of species as independent genera. *Pseudostaurastrum* was thus reduced to a few species. Rejecting *P. enorme* as the type of its genus on the grounds that this species is „unvollständig bekannt und ungenau definiert" (a charge that could be made regarding most species!), FOTT and KOMÁREK, after consulting with SKUJA, proposed to refer to the genus as *Pseudostaurastrum* CHODAT emend. SKUJA with the type *P. hastatum* (REINSCH) CHODAT in BOURRELLY. They included four species in this allegedly emended concept: *P. hastatum* (for which the combining author should be cited CHODAT ex BOURRELLY rather than CHODAT in BOURRELLY), *P. lobulatum* (NÄGELI) CHODAT in BOURRELLY (for which the combining author should be cited CHODAT ex BOURRELLY), *P. trispinatum* (W. and G. S. WEST) FOTT and KOMÁREK, and *P. enorme* (RALFS) CHODAT. From the list of included species, one must conclude that the changes in authorship of the generic name and in the type species are not justified.

Radiosphaera (PASCHER) PASCHER (1937/1938, pp. 325, 549)

As discussed above (under *Meringosphaera*), this genus was initiated by PASCHER (1932a, p. 208) as a subgenus of *Meringosphaera*, differing from typical members of that genus in that the setae radiate equatorially rather than from all around the cell. The type, and only species known to PASCHER, is *R. sol* (PASCHER) PASCHER (*Meringosphaera sol* PASCHER 1932a, p. 208, Fig. 14). CROASDALE (1948, p. 279, pl. 1118: Fig. 8) described a second species, *R. nemiahi*. Later (1956, p. 161), deciding that the distinction in position of the setae was not of generic value, she returned *R. sol* to *Meringosphaera* and transferred her own species into that genus. Although very little is known about *M. sol*, from an examination of PASCHER's figures I have concluded

that this species has nothing to do with *Meringosphaera* subg. *Meringosphaera*, and more particularly *M. mediterranea*, the lectotype of the genus. It seems similar to *M. brevispina* (in subg. *Raphidosphaera*, which I have elevated to generic rank in this paper). For the present, however, I am adopting PASCHER's treatment. *Radiosphaera* PASCHER is a later homonym of *Radiosphaera* SNOW (in WARD and WHIPPLE, Fresh-water Biol. p. 156, Fig. 191. 1918) in the green algae. As a substitute I propose *Radiosphaerella*, with the type species *R. sol* (PASCHER) comb. nov. There is nothing in the original account of *Radiosphaera nemiahi* to indicate that it is a member of the *Meringosphaera* complex. I am of the same opinion regarding *M. spinosa* PRESCOTT (in PRESCOTT, H. SILVA and WADE 1949, p. 87, pl. 1: Figs. 8, 9).

Rhizochloris PASCHER (1917b, p. 31)

This genus was founded on *R. mirabilis* PASCHER. Therefore, the citation by STARMACH (1968, p. 33) of *R. stigmatica* PASCHER (1932b, p. 314) as the type is incorrect.

Tetraedriella PASCHER (1930b, p. 423)

FOTT (1967, p. 358) transferred *Tetraedron regulare* KÜTZING, the type of *Tetraedron* KÜTZING (1845, p. 129), a genus traditionally referred to the green algae, to *Tetraedriella*. He apparently based his opinion, not on the protologue or the type specimen of *T. regulare*, but on a comparison of his own collections of *Tetraedriella gigas* (PASCHER) G. M. SMITH with descriptions and illustrations given by certain workers subsequent to KÜTZING. COMPÈRE (1975, 1977a and b) noted this shortcoming and expressed the opinion that the original diagnosis of *Tetraedron regulare* applies somewhat better to a green alga than to a yellow-green alga. (According to COMPÈRE, the original material used by KÜTZING seems to be no longer available, a fact that has been confirmed at my request by Dr. W. F. PRUD'HOMME VAN REINE of the Rijksherbarium, Leiden.) The nomenclatural repercussions of these two competing taxonomic opinions are as follows:

If *Tetraedron regulare* is truly a yellow-green alga congeneric with *Tetraedriella*, the latter name should be conserved to preclude the confusion that would result from having it displaced by *Tetraedron*, a name traditionally associated with Chlorophyceae. Those green algae now referred to *Tetraedron* would need another generic name. This solution was undertaken by KOVÁČIK and KOMÁREK (1976), who proposed that *Tetraedriella* be conserved against its earlier alleged synonym *Tetraedron*. At the same time, they sought an existing generic name to apply to the chlorococcal species that had been assigned to *Tetraedron*. After considering and rejecting several possibilities, they concluded that the best course was "to conserve the name "*Tetraedron*" sensu KORŠIKOV (1953), who first had used this name, excluding all the xanthophycean species". Their inclusion of *Polyedrium* NÄGELI (1849, p. 83) as a rejected name in both proposals is in conflict with their statement that this name is a synonym of *Tetraedron* KÜTZING. As such, it would apply to yellow-green algae and would have nothing to do with *Tetraedron* KORŠIKOV.

In the absence of unequivocal proof that *Tetraedron regulare* applies to a xanthophycean alga, it seems best to continue to treat *Tetraedron* KÜTZING as a genus of

green algae, as suggested by COMPÈRE. The latter, however, is of the opinion that the original description of *Polyedrium* is more likely to apply to a yellow-green alga than that of *Tetraedron*. Hence, he would retain the proposal to conserve *Tetraedriella* against *Polyedrium*. Neither KOVÁČIK and KOMÁREK nor COMPÈRE indicates that any attempt was made to locate and examine the material upon which *Polyedrium* was based so that the problem remains unresolved.

Of the two species originally included in *Tetraedriella*, *T. acuta* PASCHER was designated lectotype by A. R. LOEBLICH III (1967, p. 234).

Tetraplektron FOTT (1957, pp. 284, 312)

This name was proposed as a substitute for *Tetrakentron* PASCHER (1937/1938, pp. 328, 595), a later homonym of *Tetracentron* D. OLIVER (in HOOKER's Icones Plantarum no. 1892. 1889) in the Tetracentraceae (Spermatophyta). FOTT explicitly indicated the type as *T. tribulus* (PASCHER) FOTT (*Tetrakentron tribulus* PASCHER), so that the citation of *T. acutum* (PASCHER) FOTT (*Tetrakentron acutum* PASCHER) as type by STARMACH (1968, p. 167) is incorrect.

Trachychloron PASCHER (1937/1938, pp. 326, 479, 504)

This genus originally comprised seven species. In a review of the genus, FOTT (1961, p. 66) remarked: "A typical species (type-species) of the genus *Trachychloron* was not stated up to this time. It might be *Trachychloron ellipsoideum* (PASCHER) PASCHER [*Arachnochloris ellipsoidea* PASCHER], as it displays the main characteristics of the genus and its variability is well known". Despite the choice of words "might be", I believe that FOTT's statement should be accepted as a lectotypification. Subsequently, the genus has been lectotypified with *T. agloë* (PASCHER) PASCHER (*Arachnochloris agloë* PASCHER) by A. R. LOEBLICH III (1967, p. 234) and with *T. simplex* PASCHER by STARMACH (1968, p. 137).

Trachycystis PASCHER (1937/1938, pp. 324, 479, 488)

This generic name is a later homonym of *Trachycystis* LINDBERG (Not. Sällsk. Fauna et Fl. Fenn. Förh. 9: 80. 1868), applied to a genus of mosses. BOURRELLY (1968, p. 182) merged this genus into *Arachnochloris* PASCHER (1930b, p. 409). If it is to be recognized, as by STARMACH (1968, p. 132), it must be renamed.

Vischeria PASCHER (1937/1938, pp. 328, 553)

This genus originally comprised two subgenera: *Vischeria*, with three certain and five less certain species; and *Onkosphaera*, with one species. In his systematic lectotypification of xanthophycean genera, A. R. LOEBLICH III (1967) overlooked *Vischeria*. From among the species of subgenus *Vischeria*, STARMACH (1968, p. 155) chose *V. stellata* (R. CHODAT) PASCHER (*Chlorobotrys stellata* R. CHODAT) as lectotype. This species has been shown to be eustigmatophycean (HIBBERD and LEEDALE 1970, 1971b, 1972), so that the generic name must be deleted from Xanthophyceae s. str. Whether other species assigned to *Vischeria* are eustigmatophycean remains to be shown.

Summary of Names of Higher Taxa in the Yellow-Green Algae

(note: names are valid unless otherwise indicated)

I. Names of taxa with rank above family, hence not subject to typification and priority.

A. Names applicable to yellow-green algae in their entirety.

division Heterocontae Diels (1936, p. 14)
division Heterokontae Pascher (1931, p. 324, invalid; 1937, p. 203)
division Xanthophyta Hollerbach and Polyansky (1951, pp. 14, 188) (termed phylum by Margulis 1974, p. 15, and by Leedale 1974, p. 269)
phylum Xanthophyceae Dillon (1963, p. 81, invalid)
subphylum Heterocontae Sakisaka and Sinoto (1930, pp. 288, 292, invalid)
class Heterokontae Luther (1899, p. 17)
class Heterocontae Oltmanns (1904, p. 18)
class Xanthophyceae P. Allorge ex Geitler (1930b, p. 321, invalid)
class Xanthophyceae P. Allorge ex Fritsch (1935, p. 470)
subclass Tribonemeae Tilden (1935, p. 337)
order Confervales Borzì (1889, p. 68).

B. Names applicable to groups segregated from the yellow-green algae.

division or phylum Siphonophyta Kimura (1953, pp. 98, 99, invalid)
phylum Vaucheriophyta Maekawa (1953, p. 111, invalid)
class Xanthosiphonophyceae Kimura (1963, p. 296, invalid)
phylum Eustigmatophyta Hibberd (1972, p. 281, invalid)
class Eustigmatophyceae Hibberd and Leedale (1970, p. 758, invalid; 1971b, p. 524)

C. Names applicable to subdivisions of the yellow-green algae.

Rhizopodial and Monad Evolutionary Lines Jointly

class Xanthomonadina Deflandre (1952, p. 212)
subclass Heterochlorididae Olds (1972, p. 26, invalid)

Rhizopodial Evolutionary Line

class Rhizochloridineae Pascher (1931, p. 324, invalid; 1932b, p. 312)
= Rhizochlorophyceae Dedusenko-Shchegoleva and Hollerbach (1962, pp. 31, 32)
subclass Rhizochlorophycidae Starmach (1968, p. 32, invalid)
order Chlamydomyxales Engler (1898, p. 8) = Chlamydomyxidea Poche (1913, p. 193)
order Rhizochloridales Pascher (1925, p. 26) = Rhizochloridea Deflandre (1952, p. 220)
order Xanthorhizidales Chadefaud (1960, pp. 227, 242, invalid)
suborder Rhizochloridinae Pascher (1914, pp. 143, 158) = Rhizochloridina R. P. Hall (1953, p. 133)
suborder Heterorhizidineae Fritsch (1935, pp. 480, 503)

Monad Evolutionary Line

class Heterochloridineae Pascher (1931, p. 324, invalid; 1937, pp. 204, 205)
= Heterochlorophyceae Dedusenko-Shchegoleva and Hollerbach (1962, pp. 32, 37)
subclass Heterochlorophycidae Starmach (1968, pp. 32, 45, invalid)
order Heterochloridales Pascher (1912, p. 10) = Heterochloridina Doflein and Reichenow (1928, p. 348) = Heterochloridea Walton (1931, p. 51) = Heterochlorida Pearse (1936, p. 6) = Heterochloridida Cheissin and Poljansky (1963, p. 348)
order Xanthomonadales Chadefaud (1950, p. 790, invalid; 1960, pp. 227, 233, invalid)

order Chloramoebales SILVA (1962, p. 836)
suborder Heterochloridinae (1914, pp. 143, 158) = Heterochlorineae FRITSCH (1935, pp. 470, 503) = Euheterochlorina R. P. HALL (1953, p. 133)

Palmelloid Evolutionary Line

class Heterocapsineae PASCHER (1931, p. 324, invalid; 1932b, p. 319) = Heterocapsophyceae DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962, pp. 32, 43)
subclass Heterocapsophycidae STARMACH (1968, pp. 32, 57, invalid) = Heterocapsidae OLDS (1972, p. 26, invalid)
order Heterocapsales PASCHER (1912, p. 13)
order Malleodendrales ETTL (1956, p. 423)
order Pleurochloridellales ETTL (1956, p. 423)
order Characidiopsidales ETTL (1957, p. 223, invalid)
order Heterogloeales FOTT (1959, pp. 126, 130, invalid)
order Heterogloeales FOTT ex P. C. SILVA (herein)
suborder Heterocapsineae FRITSCH (1935, pp. 474, 503) = Heterocapsina R. P. HALL (1953, p. 134)

Coccoid Evolutionary Line

class Heterococcineae PASCHER (1931, p. 324, invalid; 1932b, p. 329) = Heterococcophyceae DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962, pp. 32, 55)
class Heterosphaerineae ETTL (1957, p. 221)
subclass Heterococcophycidae STARMACH (1968, pp. 32, 72, invalid)
order Heterococcales PASCHER (1912, p. 14)
order Xanthococcales CHADEFAUD (1950, p. 790, invalid)
order Characiopsidales ETTL (1957, p. 223, invalid)
order Gloeobotrydales ETTL (1957, p. 223)
order Mischococcales FOTT (1959, pp. 126, 131, invalid)
order Xanthosphaerales CHADEFAUD (1960, pp. 227, 233, invalid)
order Mischococcales FOTT ex P. C. SILVA (1962, p. 836)
suborder Chlorobotrydinae PASCHER (1915, p. 491)
suborder Sciadiinae PASCHER (1915, p. 492)
suborder Heterodendrineae FRITSCH (1935, pp. 478, 503)

Coccoid and Siphonous Evolutionary Lines Jointly

subclass Heterosiphonidae OLDS (1972, p. 26, invalid)

Filamentous Evolutionary Line

class Heterotrichineae PASCHER (1931, p. 324, invalid; 1932b, p. 337) = Heterotrichophyceae DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962, pp. 32, 213)
subclass Heterotrichophycidae STARMACH (1968, pp. 32: "Heterothrichophycidae", 311, invalid) = Heterotrichidae OLDS (1972, p. 26, invalid)
order Heterotrichales PASCHER (1912, p. 18)
order Heterocloniales PASCHER (1939, pp. 915, 991)
order Tribonematales PASCHER (1939, p. 915)
order Xanthotrichales CHADEFAUD (1950, p. 790, invalid; 1960, pp. 226, 227, invalid)

Siphonous Evolutionary Line

class Heterosiphoneae PASCHER (1931, p. 324, invalid)
class Heterosiphonineae PASCHER (1937/1939, pp. 204, 1023) = Heterosiphonophyceae DEDUSENKO-SHCHEGOLEVA and HOLLERBACH (1962, pp. 32, 249)
subclass Heterosiphonophycidae STARMACH (1968, pp. 32, 359, invalid)
order Vaucheriales BOHLIN (1901a, p. 21)

order Heterosiphonales PASCHER (1912, p. 21)
order Botrydiales SCHAFFNER (1922, p. 133)
order Xanthosiphonales CHADEFAUD (1950, p. 790, invalid; 1960, pp. 227, 230, invalid)

II. Names of families, subfamilies, and tribes, subject to typification and priority.

Rhizopodial Evolutionary Line

Chlamydomyxida GEDDES (1882, p. 34, invalid; "order" = family)
Chlamydomyxaceae ENGLER (1897, p. 570) = Chlamydomyxidae POCHE (1913, p. 194)
Chlorarachniaceae PASCHER (1937, pp. 239, 251) = Chlorarachnidae DEFLANDRE (1952, p. 222) (see text regarding the taxonomic position of this family)
Heterorhizidaceae BURSA (1954, p. 11, invalid)
Myxochloridaceae PASCHER (1937, p. 256) = Myxochloridídae DEFLANDRE (1952, p. 222)
Rhizochloridaceae PASCHER (1925, p. 26) = Rhizochloridídae DEFLANDRE (1952, p. 220)
Rhizochloridoideae PASCHER (1937, pp. 238, 239, "Rhizochlorideae"; subfamily)
Rhizogranulochloridaceae SKVORTZOV (1972, p. 5, invalid)
Rhizolekanaceae DEFLANDRE (1952, p. 221, "Rhizolekanidae")
Rhizounochloridaceae SKVORTZOV (1972, pp. 2, 3, invalid)
Stipitochloridaceae DEFLANDRE (1952, p. 221, "Stipitochloridídae", invalid)
Stipitococcaceae PASCHER (1931, p. 324, invalid)
Stipitococcaceae PASCHER ex G. M. SMITH (1933, p. 144)
Stipitococcoideae PASCHER (1937, pp. 238, 243, "Stipitococceae"; subfamily)

Monad Evolutionary Line

Chloramoebaceae A. LUTHER (1899, p. 19) = Chloramoebidae POCHE (1913, p. 155)
Heterochloridaceae PASCHER (1925, p. 22, illegitimate)

Palmelloid Evolutionary Line

Characidiopsidaceae ETTL (1956, p. 425)
Chlorosaccaceae BOHLIN (1901a, p. 25, invalid)
Chlorosaccaceae BOHLIN ex BLACKMAN and TANSLEY (1902, p. 217)
Helminthogloeoideae PASCHER (1937, pp. 278, 296, "Helminthogloeae"; subfamily)
Heterocapsaceae PASCHER (1912, pp. 13, 21, invalid)
Heterocapsoideae PASCHER (1937, pp. 277, 278, "Heterocapseae", invalid; subfamily)
Heterogloeaceae FOTT (1959, p. 130, invalid)
Heterogloeaceae FOTT ex P. C. SILVA (herein)
Malleodendraceae PASCHER (1937, pp. 277, 301)
Pleurochloridellaceae ETTL (1956, p. 423)

Coccoid Evolutionary Line

Asterogloeaceae ETTL (1957, p. 223)
Asterogloeoideae PASCHER (1937/1938, pp. 319: "Asterogloeeae", 526: "Asterogloeae": subfamily)
Botrydiopsidoideae WILLE (1909, pp. 42, 44, "Botrydiopseae"; subfamily)
Botrydiopsideae BORZÌ (1889, p. 69; tribe)
Botryochloridaceae PASCHER (1937/1938, pp. 321, 661)
Botrychloridoideae PASCHER (1937/1938, pp. 320, 662, "Botryochlorideae"; subfamily)
Centritractaceae PASCHER (1937/1938, pp. 321, 830)
Characiopsidaceae PASCHER (1937/1938, pp. 321, 718)
Chlorellidiaceae KOMÁREK (1964, p. 9, invalid)

Chlorellidioideae PASCHER (1937/1938, pp. 320, 662, 683, "Chlorellidieae"; subfamily)
Chlorobotrydaceae PASCHER (1915, p. 491) (Eustigmatophyceae)
Chlorobotrydoideae PASCHER (1915, p. 491, "Chlorobotrydeae"; subfamily) (Eustigmatophyceae)
Chlorokorynoideae PASCHER (1937/1938, pp. 319, 529, "Chlorokoryneae"; subfamily)
Chloropediaceae PASCHER (1931, p. 324)
Chloropedioideae PASCHER (1937, p. 321, "Chloropedieae"; subfamily)
Chlorotheciaceae BOHLIN (1897, p. 48)
Chlorothecioideae WILLE (1909, pp. 43, 46, "Chlorothecieae"; subfamily)
Ellipsoidicideae PASCHER (1937, p. 407, "Ellipsoideae", illegitimate; subfamily)
Gloeobotrydaceae PASCHER (1937/1938, pp. 320, 632, illegitimate)
Gloeopodiaceae PASCHER (1937/1938, pp. 320, 696)
Gloeopodioideae PASCHER (1937, p. 320, "Gloeopodieae"; subfamily)
Goniochloridoideae PASCHER (1937/1938, pp. 320, 606, "Goniochlorideae"; subfamily)
Lutherelloideae PASCHER (1937, p. 321, "Lutherelleae"; subfamily)
Meringosphaeroideae PASCHER (1937/1938, pp. 319, 535, "Meringosphaereae"; subfamily)
Mischococcaceae PASCHER (1912, p. 14)
Mischococcoideae WILLE (1909, p. 33, "Mischococceae"; subfamily)
Monodoideae PASCHER (1937, p. 319, "Monodeae"; subfamily)
Ophiocytiaceae LEMMERMANN (1899, p. 26, illegitimate)
Ophiocytioideae RABENHORST (1868, p. 66, "Ophiocytieae"; subfamily)
Pleurochloridaceae PASCHER (1937, pp. 319, 333)
Pleurochloridoideae PASCHER (1937, pp. 319, 333, "Pleurochlorideae"; subfamily)
Polyedrielloideae PASCHER (1937/1938, pp. 319, 552, "Polyedrielleae"; subfamily)
Sciadiaceae GOBI (1887, p. 384, "Sciadieae")
Sciadioideae FILARSZKY (1900, p. 144, "Sciadieae"; subfamily)
Tetraktidaceae KOMÁREK (1964, p. 9)
Tetraktidoideae PASCHER (1937/1938, pp. 320: "Tetraktineae", 662, 670: "Tetraktideae"; subfamily)
Tetraedrielloideae PASCHER (1937/1938, pp. 320, 583, "Tetraedrielleae"; subfamily)
Trachychloroideae PASCHER (1937, p. 479, "Trachychlorideae", illegitimate; subfamily)
Trachycystidoideae PASCHER (1937, p. 319, "Trachycystideae"; subfamily)
Trypanochloridaceae GEITLER (1935, p. 146, invalid)
Trypanochloridaceae GEITLER ex PASCHER (1937/1938, pp. 321, 825)

Filamentous Evolutionary Line

Aeronemataceae FOTT (1971, p. 132, invalid)
Bumillerieae BORZÌ (1889, p. 69; tribe)
Heterocloniaceae PASCHER (1931, p. 324, invalid)
Heteroclonioideae PASCHER (1939, pp. 997, 998, invalid; subfamily)
Heterococcaceae P. C. SILVA (herein)
Heterodendraceae PASCHER (1939, p. 992, illegitimate)
Heteropedioideae PASCHER (1939, p. 997: "Heteropodieae", 1012: "Heteropedieae"; subfamily)
Heterotrichaceae PASCHER (1939, p. 916, illegitimate)
Monociliaceae G. S. WEST (1916, p. 414, illegitimate)
Tribonemataceae G. S. WEST (1904, pp. 249, 253, "Tribonemaceae", illegitimate)
Tribonemataceae PASCHER (1912, p. 18, "Tribonemaceae")

Siphonous Evolutionary Line

Botrydiaceae RABENHORST (1863, pp. 219, 222)
Botrydieae BORZÌ (1889, p. 70; tribe)
Hydrogastraceae RABENHORST (1868, pp. 262, 265, "Hydrogastreae")

Hydrogastreae ENDLICHER (1843, p. 19; tribe)
Phyllosiphonaceae FRANK (1886, p. 176, "Phyllosiphoneae")
Vaucheriaceae DUMORTIER (1829, p. 77)
Vauchericeae S. F. GRAY (1821, pp. 278, 288, "Vaucherideae"; subfamily)
Vaucherieae E. M. FRIES (1825, p. 340; tribe)

Acknowledgements

Foremost, I am indebted, like all phycologists, to ADOLF PASCHER for an incredibly rich heritage. The continuation of the great Pascherian tradition by the late Professor BOHUSLAV FOTT occupies an equally important place in the history of fresh-water phycology. I am grateful for Professor FOTT's sustained support and encouragement of my work. It is a pleasure to express my appreciation to TYGE CHRISTENSEN of the Institut for Sporeplanter, København, for providing the Latin diagnoses and for linguistic counsel. Much of the research was undertaken with financial support from the National Science Foundation (Grants G 23743, 1962—1964, and GB 2310, 1964—1966). I am especially appreciative of these grants because they enabled me to obtain and enjoy the unusually competent bibliographic assistance of Miss NEL C. REM.

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