

MORPHOLOGICAL AND CULTURE STUDIES IN TWO SPECIES OF
PREDAEA G. De TONI (RHODOPHYTA, GYMNOPLAEACEAE)
FROM THE CARIBBEAN SEA¹

ANDRÉS J. LEMUS and E. K. GANESAN

Instituto Oceanográfico, Universidad de Oriente, Cumaná, Venezuela

ABSTRACT: Observations on the vegetative anatomy and reproduction of 2 species of *Predaea*, *P. feldmannii* BORGESEN and *P. pusilla* (BERTHOLD) J. FELDMANN (Rhodophyta, Gigartinales) from eastern Venezuela are described and illustrated. *Predaea pusilla*, a little known species recorded previously only from the Bay of Naples by BERTHOLD (1884) constitutes a new addition to the flora of the western Atlantic ocean. Only macroscopic, field-collected gametangial (carposporangial and spermatangial) plants have been reported hitherto for the 6 described species of *Predaea*. Carpospores of *P. feldmannii* grown under controlled laboratory conditions developed into microscopic, branched filaments with an acrochaetoid morphology, some of the terminal cells of which were transformed into tetrasporangia. Similarly, carpospores of *P. pusilla* cultured in the laboratory developed into minute, irregular discoid structures consisting of a two-cell layered basal region, and erect filaments which cover tetrasporangia. This is the first report of the existence of a minute heteromorphic tetrasporangial phase in the life-history of *Predaea* and in a member of Gymnophlaeaceae. Our morphological and culture studies are compared and discussed in the light of information known for the other members of the family.

RESUMEN: En base al material recolectado en el oriente de Venezuela, se describen e ilustran observaciones morfológicas de la anatomía vegetativa y reproducción en dos especies del género *Predaea*, *P. feldmannii* y *P. pusilla* (Rhodophyta, Gigartinales). De estas dos especies, *P. pusilla* constituye una nueva adición a la flora del Océano Atlántico occidental, puesto que la única cita es la del BERTHOLD (1884) quien la señala para la Bahía de Nápoles. Se conocen hasta ahora en las seis especies descritas de *Predaea* sólo plantas macroscópicas gametangiales (carposporangiales y espermatangiales) en el campo. Carpósporas de *P. feldmannii* cultivadas bajo condiciones controladas del laboratorio se desarrollaron en forma de filamentos ramificados microscópicos (semejante al género *Acrochaetium*) y algunas células terminales produjeron tetrasporangios. De la misma manera, carpósporas de *P. pusilla* formaron estructuras menudas discoidales de forma irregular y de dos capas de células y con tetrasporangios cubiertos por filamentos erectos. Esta es la primera cita de la existencia de una fase tetrasporangial heteromórfica en el ciclo vital de *Predaea* y en un miembro de la familia Gymnophlaeaceae. Se comparan y discuten nuestras observaciones morfológicas y de cultivo con las literaturas conocidas para los otros miembros de la familia Gymnophlaeaceae.

INTRODUCTION

The family Gymnophlaeaceae (Rhodophyta, Gigartinales) to which *Predaea* G. De Toni belongs, includes 5 other genera: *Adelophytton* KRAFT, *Nemastoma* J. AG., *Platoma* SCHMITZ, *Schizymenia* J. AG. and *Titano-*

1. This study represents a part of a dissertation presented by the first author to the School of Post-Graduate Studies in Oceanography Universidad de Oriente, Cumaná, Venezuela, in partial fulfillment of the requirements for the degree of Master of Science.

phora (J. AG.) J. FELDMANN. Members of these genera are known from widely separated geographical latitudes from the tropics to subarctic waters. Of these, *Predaea* is unique in possessing special nutritive cells, called "cellules nourricières" (FELDMANN, 1942) or "Celules" (KRAFT & ABBOTT, 1971), which are produced by the vegetative cells adjacent to the differentiated auxiliary cells. KRAFT & ABBOTT (1971), when describing *P. weldii* as a new species from Hawaii, critically analyzed and tabulated all the information regarding

habit, pre and post-fertilization development in the 6 currently recognized species of *Predaea* and also made meaningful comparisons of *Predaea* at the generic level with the other genera of the Gymnophlaeaceae (as Nemastomataceae). With subsequent contributions by SCHNEIDER & SEARLES (1973, 1975); GANESAN & LEMUS (1975); KRAFT & JOHN (1976); NORRIS & BUCHER (1977) and IRVINE *et al* (1978), several members of the family are increasingly better understood and evaluated, although Gymnophlaeaceae still contains many ill-defined and/or little known taxa. It should be pointed out that *Platoma* and *Nemastoma* are not clearly differentiated from each other (see KRAFT & JOHN, 1976; NORRIS & BUCHER, 1977).

Of the 6 species of *Predaea*, *P. feldmannii* was reported recently (GANESAN & LEMUS, 1975) as a new addition to the Caribbean sea flora. Subsequently another species, *P. pusilla* was collected by us from the same place as that of *P. feldmannii*. *P. pusilla* appears to be an extremely rare alga; the only information we have at present about this species is restricted to the original collection and description given by BERTHOLD (1884) with respect to the material from the Bay of Naples (KRAFT & ABBOTT, 1971, p. 200).

Culture studies for members of the Gymnophlaeaceae are also very few (see UMEZAKI, 1974, p. 346). *Predaea* and *Titanophora* are the only two genera of the family restricted to tropical and sub-tropical latitudes and for which tetrasporophytes have never been reported from field collected material (KRAFT & ABBOTT, 1971; KRAFT & JOHN, 1976). No member of *Predaea* has ever been subjected to culture studies under controlled laboratory conditions. We present in this work the results of our morphological and culture studies on 2 species of *Predaea*, from eastern Venezuela.

MATERIALS AND METHODS

Both *Predaea feldmannii* and *P. pusilla* were obtained growing side by side at Punta Mosquito, south-east coast of Margarita Island. They were collected by trawling from 10 m on 31.iii.'76 and by snorkel diving from 14 m on 14.ii.'77 and 26.ii.'77. The material was brought alive to the laboratory in seawater from the place of collection. The plants were maintained alive in the laboratory for several days with vigorous aeration provided by aquarium aerators and changing

of the seawater every day until cultures were established. For the study of anatomical and reproductive details, some of the field-collected gametophytes were fixed in 4% seawater formalin. The material was stained in 1% aqueous aniline blue and mounted in Karo syrup. Entire plants were also mounted on herbarium sheets without pressure. Since thalli of both the species are in the form of delicate mucilaginous sacks, this method of drying helped considerably to maintain certain details such as branching pattern and nature of thallus margins.

For culture studies, 3 different media as given by SCHREIBER (1927), PROVASOLI (1968) and EDWARDS (1970) (see also MCLACHLAN, 1973) were used. Small pieces of thalli with mature gonimoblasts were thoroughly washed with sterile seawater to eliminate epiphytes and left on cover slips in Petri dishes containing about 10 ml of the culture medium. The Petri dishes were left in growth chambers with 23 °C temperature, 12:12 photoregime and 1484 lux of light intensity. Carpospores were liberated after 2-3 days and were allowed to settle on cover slips in Petri dishes containing the three respective media by means of a Pasteur disponible pipette, the tip of which was previously drawn into a capillary tube. Developmental sequence was observed *in vivo* with a compound microscope. Photo-micrographs were taken with a Leitz Combiphot automatic photographic equipment. Kodak panchromatic B & W 32 ASA film was used. Line drawings were made with the aid of a Camera Lucida.

All cultures were maintained unialgal. Diatom growth was eliminated by adding 10 mg GeO₂/l which was prepared and used according to the method given by WEST (1970). Light intensity was measured by a visual and cosine-corrected Weston (Model 756) illumination meter. The culture medium was repleted every 10 days.

Two models of growth chambers (Lab-Line Ambi HI-LO Chamber & Percival model L-30 B LL) with the following combination of environmental conditions were used.

23°C; 12:12 photoregime and 1484 lux.

23° C; 8:16 photoregime upper chamber- 1219 lux & lower chamber- 954 lux.

No appreciable difference in growth rate was observed in the 3 media or in the different environmental conditions mentioned above.

Duplicate specimens (liquid preserved and herbarium mounts) are deposited in the Herbarium, Dept. of Marine Biology, Institute of Oceanography, Cumaná, Venezuela. Duplicate herbarium mounts were also sent to the Herbarium, University of California, Berkeley, California, U.S.A.

OBSERVATIONS

Predaea feldmannii BORGESSEN
(Figs. 1-18; 41-43)

Field collected material:

Vegetative anatomy and reproductive details of this species were treated by us in an earlier paper (GANESAN & LEMUS, 1975) although that study was based on only 4 specimens. Subsequently, additional collections were made from the same locality and a recent contribution on *P. feldmannii* from Ghana (KRAFT & JOHN, 1976) prompted us to undertake the present study. In general, our present observations agree well with the earlier studies. The following points, however, seem worthy of mention.

Two types of plants with different morphological aspects (dimorphic) were not recognized in our collections. Although there was considerable variation in thallus size, branching and lobulations, all our plants, as judged from liquid preserved material, belonged to the narrow form, composed of tubes with abundant marginal rounded lobes or bullations (Fig. 1). Neither moniliform cells nor gland cells were observed in the thallus cortex. Terminal prolongations in the form of hairs issuing from some of the surface cells of the cortex were absent in the present material (cf. GANESAN & LEMUS, 1975, p. 160, fig. 3). All our plants had auxiliary cells with the characteristic "celulles".

In certain cases, unfertilized auxiliary cells were seen to be divided into 2 approximately equal halves by an equatorial fissure or canal (Fig. 2, AC). In the diploidized auxiliary cell, the young gonimoblast arose laterally from the basal cell with which the connecting filament had fused (Figs. 3,4). Division of auxiliary cells into 2, although infrequently observed by us, is not reported hitherto in any species of *Predaea*. Delicate septate connecting filaments, initially developing as isodiametric cells (Fig. 41), were also present in our material. Neither separate male plants nor structures

resembling spermatangia in the cortex of the female plants of the present collection were observed by us. BORGENSEN (1950) and KRAFT & JOHN (1976) have reported separate male plants, which shows that this species is dioecious.

Culture studies:

The liberated carpospores are spherical, 8-10 μm in diameter (Fig. 5) and germinate 2-3 days following liberation. A daughter cell either of the same size and shape as the mother cell (Fig. 6), or different in size and form (Fig. 8 left), is produced by the germinating carpospore. By subsequent growth and division, a small uniseriate filament up to 15 cells long (Figs. 7, 8, 9) is formed. This stage is reached within approximately one week. Only a single filament issues from each carpospore. Cell shape and size are very variable in the filament (Figs. 7, 8). In 12-15 days, small irregularly arising lateral branches are produced (Fig. 10). Each cell has many elongate parietal chloroplasts and dense contents (Fig. 11). With branches of the second order also arising irregularly, the filaments attain a characteristic acrochaetioid morphology (Fig. 12). Neither hair formation nor monospore production was observed in the filaments. These microscopic, filamentous branched structures remained vegetative for nearly 3 months. Afterwards, some of the terminal cells of the lateral branches became notably enlarged and the contents divided into 4 parts, showing that they were tetrasporangia (Figs. 13 to 18). Division of the tetrasporangia is very variable i.e. cruciate (Fig. 15), zonate (Fig. 13, 16) and irregular (Figs. 14, 17). Mature tetrasporangia were up to 12-19 μm long (rarely to 24 μm) and 7-13 μm broad. Individual tetraspores measure 6-7 μm in diameter. The 4 tetraspores frequently leave the sporangium as a group (Fig. 18). In a single case, *in situ* germination of a tetraspore was observed (Fig. 42).

Predaea pusilla (BERTHOLD) J. FELDMANN
(Figs. 19-40; 44-51)

Field collected material:

Plants of *P. pusilla* grow on a wide variety of hard substrates such as rocks, polychaete tubes, and mollusk shells (generally *Arca zebra*). The fronds up to 10 cm

in height are delicate, copiously mucilaginous with a dark red or pink color in the living state. A conspicuous basal disc was not evident. Thallus branching is sub-dichotomous to irregular (Fig. 19) with the ultimate branchlets in the form of tubes ending in acute apices (Fig. 20). In addition, the thallus surface is provided with many, small, irregular lobes (Fig. 20, left). Structurally, the thallus is multiaxial with many elongated, sparsely branched medullary filaments (4.5 μm broad) and a cortex of repeated dichotomously branched filaments with rectangular cells (Fig. 21). Neither hair cells nor densely staining gland cells were observed in the cortex. Rhizoidal filaments originating from the inner cortex and directed towards the medulla were observed, but not very abundantly.

Carpogonial branches are produced in the inner cortical region (Figs. 44, 45) and are composed of 3 cells (Figs. 23, 44, 45). The basal cell is generally pyriform, 11-15 μm long and 6-10 μm broad, the hypogynous cell is more rounded, 8-10 μm across and the carpogonium possesses a long trichogyne.

Like the carpogonial branches, the auxiliary cells are also produced in the inner cortical region, but they are far more numerous. A vegetative cell at the base of a dichotomy in the inner cortex functions as the auxiliary cell (Fig. 44). Soon after its formation, the vegetative cell immediately below the auxiliary cell, and the two basal cells of the dichotomy above it, considerably increase in size and acquire dense contents. It is from these 3 cells that 3 groups of characteristic nutritive cells are formed (Figs. 24-26; 46-48). The prominent 'celulles' are few in number, of large size (6-13 μm diameter), spherical and unbranched or branched once or twice.

After fertilization, each carpogonium produced many long, delicate, branched and septate connecting filaments (Figs. 27, 49, 50). Small isodiametric cells may or may not be present between the fertilized carpogonium and the elongate connecting filaments. After diploidization by a connecting filament (Fig. 28), a prominent gonimoblast initial is cut off terminally from the auxiliary cell (Figs. 28, 51). The apical differentiation of the gonimoblast initial appears to be a consistent feature, since a lateral origin of the initial was never observed. With the formation and subsequent development of the gonimoblast initial, pit-connec-

tions between the 'celulles' become wider (Fig. 51). Up to 3 gonimolobes per gonimoblast were observed. Fully developed gonimoblast measure 215-325 μm long and 135-245 μm broad.

Sexual plants were monoecious. Small rounded spermatangia were borne on elongate spermatangial mother cells in the outer cortex (Fig. 22). In the spermatangial region, dichotomous branchings were less frequent than in the region with carpogonial branches and auxiliary cells.

Culture studies:

Liberated carpospores (Fig. 30) are rounded, variable in size, 6-10 μm in diameter and germinate after approximately 24 hours after their release. In contrast to *P. feldmannii*, carpospores of *P. pusilla* remained undivided or formed two cells (Fig. 33), which give out one (Fig. 32) or two (Fig. 31) or 3 daughter cells (Fig. 34, top left). Carpospore germination is thus variable in *P. pusilla*. After 3 to 5 days, uniseriate filaments 4-8 cells long, (Fig. 34, left) with one to 3-celled lateral branches (Fig. 34, right) are formed. Continued growth resulted in a characteristic acrochaetoid morphology (Fig. 35) with lateral branches of a second and third order. However, in later stages, branching becomes more dense at the base and central part, and these branches are densely aggregated into an irregular discoid structure (Fig. 39), the acrochaetoid morphology eventually being lost. The basal part then becomes more than 1-layered producing free, erect branched filaments. Cell size is very variable in the different parts of the germlings and each cell has many elongate parietal chloroplasts (Fig. 37). These minute discoid structures of a few mm diameter remained vegetative for 2 months in the cultures studied both in 1976 and 1977. However, in the cultures of 1976, some of the terminal cells in the densely aggregated part became enlarged with dark contents and divided into 4 parts (Figs. 36, 38, 40). To observe the tetrasporangia, thus formed it was invariably necessary to exert some slight pressure on the cover slip, which helped to separate the dense covering of free filaments. Fully mature tetrasporangia were cruciately (Fig. 40 lower right) to irregularly divided (Figs. 36, 38) and were up to 24 μm and 9-11 μm diameter. The cultures studied in 1977 remained sterile.

DISCUSSION

Our observations on vegetative anatomy and reproductive details of the field collected female plants of *P. feldmannii* agree well in general with the findings in earlier studies on this species (BORGESEN, 1950; SCHNEIDER & SEARLES, 1975; GANESAN & LEMUS, 1975; KRAFT & JOHN, 1976). Points of interest shown by the present Venezuelan material are: (i) the apparent lack of sexual dimorphism or more precisely the absence of the so called "male" forms of *P. feldmannii* with moniliform cortical cells and gland cells, and (ii) the division of auxiliary cells into 2 halves before diploidization and the gonimoblast arising laterally from the lower half of the auxiliary cell. Only future studies on collections of *P. feldmannii* from St. Helena Island (the type locality) will settle the question whether *P. feldmannii* is dimorphic (see however KRAFT & JOHN, 1976, p. 343). The lateral origin of the gonimoblast initial in our material was consistent and hence we agree with KRAFT & JOHN that this feature, considered in conjunction with other characteristics, is of value to distinguish *P. feldmannii* from related species.

A comparison of our observations on the second species of *Predaea* present in Venezuela with information in the Table given by KRAFT & ABBOTT (1975, p. 200) would show that our plants are similar to both *P. pusilla* and *P. weldii* with respect to (i) 3-celled carpogonial branches (ii) a smaller number of 'celulles', and more importantly (iii) a terminal origin of the gonimoblast initial. Since all our plants belonged to only one morphological type i.e., in habit consisting of subdichotomously branched tubes as contrasted with *P. weldii* which is dimorphic, we assign our material to *P. pusilla*. Also, it must be pointed out that the identity of *P. weldii* is not clear. In a recent paper, KRAFT & JOHN (1976) stated that *P. weldii* should probably be reinvestigated since the original collection seemed to contain an element very similar to the realted genus *Nemastoma*, thus casting doubt on whether *P. weldii* is dimorphic. Although all the earlier information regarding *P. pusilla* is restricted to the original meagre collection and the description of BERTHOLD (1884) from the Bay of Naples (KRAFT & JOHN, 1971), we are of the opinion that our plants are best assigned to that species. *Predaea pusilla* thus becomes a new addition to the flora of the Western Atlantic Ocean.

Although *Predaea feldmannii* and *P. pusilla* grow side by side in the same place, the two species are easily distinguishable by the following features:

P. feldmannii

fronds pale or light red in color when alive.

branching irregular and the ultimate branches in the form of small lobes or tubes with rounded apices (see Ganesan & Lemus, 1975, p. 160, fig. 1).

'Celulles' numerous and small in size

gonimoblast initiated laterally

plants unisexual (dioecious)

P. pusilla

fronds dark red or pink in color when alive.

branching subdichotomous and apices of ultimate branches acute (Fig. 20).

'Celulles' few and at least 2 times broader than *P. feldmannii*

gonimoblast initiated terminally

plants bisexual (monoecious)

With the exception of *Adelophyton*, *Predaea* and *Titanophora*, tetrasporic plants have been reported in field collected material of the other 3-genera of the Gymnophlaeaceae viz., *Nemastoma*, *Platoma* and *Schizymenia* (KRAFT & ABBOTT, 1971). Recently, UMEZAKI (1974) also demonstrated by laboratory culture studies the occurrence of a *Polysiphonia* type life-history for *Nemastoma nakamuriae*. In the present work, it is shown that in 2 species of *Predaea*, *P. feldmannii* and *P. pusilla*, tetrasporangia are formed on microscopic phases that are morphologically different, although the fate of the tetraspores was not determined by us. This is the first report of the existence of a tetrasporophytic phase dissimilar to the gametophyte in *Predaea* and in a member of the Gymnophlaeaceae. Since families such as Furcellariaceae and Solieriaceae in the Gigartinales include genera with both isomorphic and heteromorphic life-history patterns (see BOILLOT, 1965; SOUTH et al, 1972), inclusion of *Predaea* along with *Nemastoma*, *Platoma* and *Schizymenia* in the same family is, in our opinion, justified. Furthermore, in external morphology (gelatinous tubes or sacks), vegetative anatomy and reproductive features, *Predaea* is closely related to both *Nemastoma* and *Platoma*.

ACKNOWLEDGMENTS

Grateful thanks are extended to Prof. G. F. PAPENFUSS and to DR. JOHN A. WEST of the Dept. of Bot-

any, University of California, Berkeley, California and to DR. DONALD F. KAPRAUN of the Dept. of Biology, University of North Carolina at Wilmington, North Carolina, U.S.A. for critically reviewing the manuscript and offering many helpful suggestions to improve the same. We are also thankful to MESSERS BRICILIO MARCANO, JORGE HERNÁNDEZ, MIGUEL GÓMEZ, HORACIO and FRANCISCO MÉNDEZ for their enthusiastic cooperation in the field and in the laboratory; to ADONAY PERNÍA and RAMÓN VARGAS for printing the photographs and to EPIFANIO HERNÁNDEZ for making the line drawings. The financial support given by the Consejo de Investigación, Universidad de Oriente, Cumaná, Venezuela to the research project CI-5-19-00089/76 is also gratefully acknowledged.

REFERENCES

- BERTHOLD, G. 1884. Die Cryptonemiaceen des Golfs von Neapel. *Fauna und Flora des Golfs von Neapel*. xii. Monogr., Leipzig.
- BOILLOT, A. 1965. Sur l'alternance de générations hétérmorphes d'une Rhodophycée, *Halarachnion ligulatum* (Woodward) Kuetzing (Gigartinales, Furcellariacées). *C. R. Acad. Sc. Paris*, 261: 4191-4193.
- BORGESEN, F. 1950. A new species of the genus *Predaea*. *Dansk Bot. Arkiv*, 14 (4): 1-8.
- EDWARDS, P. 1970. Illustrated guide to the Seaweeds and Seagrasses in the vicinity of Port Aransas, Texas. *Contr. Mar. Sci. Univ. Tex.* 15 (suppl.): 1-128.
- FELDMANN, J. 1942. Remarques sur les Némastomacées. *Bull. Soc. Bot. Fr.*, 89 (4-5): 104-113.
- GANESAN, E. K. & A. J. LEMUS. 1975. Presencia del género *Predaea* G. DeToni (Rhodophyta, Gigartinales) en Venezuela. *Bol. Inst. Oceanogr. Univ. Oriente*, 14(2): 157-163.
- IRVINE, L. M., D. E. G. IRVINE & M. D. GUIRY. 1978. Notes on Irish marine algae 2: *Platoma marginifera* (J. Ag.) Batters (Rhodophyta). *Ir. Nat. J.* 19 (6): 188-189.
- KRAFT, G. T. 1975. Consideration of the order Cryptoneiales and the families Nemastomataceae and Furcellariaceae (Gigartinales, Rhodophyta) in light of the morphology of *Adelophyton corneum* (J. Agardh) gen et comb. nov. from Southern Australia. *Brit. Phycol. J.* 10: 279-290.
- KRAFT, G. T. & I. A. ABBOTT. 1971. *Predaea weldii*, a new species of Rhodophyta from Hawaii, with an evaluation of the genus. *J. Phycol.* 7: 194-202.
- KRAFT, G. T. & D. M. JOHN. 1976. The morphology and ecology of *Nemastoma* and *Predaea* species (Nemastomataceae, Rhodophyta) from Ghana. *Br. Phycol. J.* 11 (4): 331-344.
- MCLACHLAN, J. 1973. Growth media-marine pp. 25-51. In: J. Stein (Ed.) *Handbook of Phycological Methods*. Culture methods and growth measurements. Cambridge Univ. Press. xii, 448 pp.
- NORRIS, J. N. & K. E. BUCHER. 1977. The genus *Platoma* (Gigartinales, Rhodophyta) with a description of *P. abbottiana* sp. nov. *J. Phycol.* 13: 155-162.
- PROVASOLI, L. 1968. Media and prospects for the cultivation of marine algae. In: A. Watanabe & A. Hattori (Eds.), Cultures and collection of algae. Proc. U. S. Japan Conf. Hakone, Sept. 1966. *Jap. Soc. Plant Physiol.*, pp. 63-75.
- SCHNEIDER, C. W. & R. B. SEARLES. 1973. North Carolina marine algae. II. New records and observations of the benthic offshore flora. *Phycologia*, 12: 201-211.
- 1975. North Carolina marine algae. IV. Further contributions from the continental shelf, including two new species of Rhodophyta. *Nova Hedwigia*, 26 (1): 83-103.
- SCHREIBER, E. 1927. Die Reinkultur von marinem Phytoplankton und deren Bedeutung für die Erforschung der Produktionsfähigkeit des Meerwassers. *Wiss. Meeresuntersuch. N. F.*, 16 (1): 1-34.
- SOUTH, G. R. R. G. HOOPER & L. M. IRVINE. 1972. The life history of *Turnerella pennyi* (Harv.) Schmitz. *Br. Phycol. J.* 7: 221-233.
- UMEZAKI, I. 1974. The life-history of *Nemastoma nakamurae* Yendo in culture. *J. Jap. Bot.*, 49 (11): 346-352.
- WEST, J. A. 1970. The life history of *Rhodochorton crescens* in culture. *Br. Phycol. J.* 5: 179-186.

(Manuscrito recibido el 4 de marzo de 1978).

Explanation of figures 1-4
(*Predaea feldmannii*)

- Fig. 1. Habit of a field collected female plant.
Fig. 2. Auxiliary cell divided into 2 by an equatorial groove and surrounded by "Celulles" X 720.
Fig. 3. Diploidized auxiliary cell showing incomplete division with connecting filament and gonimoblast attached to the lower half X 720.
Fig. 4. Diploidized auxiliary cell divided into 2 cells with the connecting filament and gonimoblast attached to the lower half X 720.

Explanation of figures 5-12
(*Predaea feldmannii*)

- Fig. 5. Liberated carpospores X 330.
Figs. 6-8. Carpospore germination stages X 700.
Fig. 9. About 7 days old germlings in the form of uniserial filaments X 140.
Fig. 10. About 2 weeks old germlings with irregularly arising lateral branches X 110.
Fig. 11. Part of a germling enlarged to show the dense cell contents X 770.
Fig. 12. About one month old germlings showing more abundant lateral branches (compared to those in Fig. 10), with a characteristic acrochaetiod morphology X 100.

Explanation of figures 13-20
(Figs. 13-18. *Predaea feldmannii*)
(Figs. 19-20. *Predaea pusilla*)

- Figs. 13, 16. Zonate tetrasporangia X 540.
Fig. 14. Irregularly cruciate tetrasporangium X 540.
Fig. 15. Part of a tetrasporophyte with a cruciate tetrasporangium X 540.
Fig. 17. Irregularly zonate tetrasporangium X 540.
Fig. 18. Liberated tetraspores X 540.
Fig. 19. Habit of a dried field collected female gametophyte.
Fig. 20. Liquid preserved material enlarged to show the ultimate branches in the form of tubes with acute apices.

Explanation of figures 21-29
(*Predaea pusilla*)

- Fig. 21. Vegetative anatomy showing elongate medullary cells and repeatedly dichotomously branched cortical filaments X 90.
Fig. 22. Formation of spermatangia X 440.
Fig. 23. A young carpogonial branch X 450.
Fig. 24. A young auxiliary cell with 'celulles'.
Figs. 25, 26. Two fully developed undiploidized auxiliary cells X 450.
Fig. 27. Fertilized carpogonium giving out branched connecting filaments X 440.
Fig. 28. Terminal origin of gonimoblast initial X 440.
Fig. 29. A young gonimoblast X 440.

*Explanation of figures 30-38
(*Predaea pusilla*)*

- Fig. 30. Liberated carpospores X 460.
Figs. 31-34. Carpospore germination stages X 460.
Fig. 35. Two germlings about one month old with the characteristic acrochaetioid morphology X 110.
Figs. 36, 38. Irregularly divided tetrasporangia (Fig. 36=X 740; Fig. 38=X 310).
Fig. 37. Part of a germling about 20 to 25 days old showing cell form, size and the dense branching at the base X 700.

*Explanation of figures 39-40
(*Predaea pusilla*)*

- Fig. 39. About one month old germling in the form of an irregular monostromatic disc X 700.
Fig. 40. Irregular to cruciate tetrasporangia from a squashed tetrasporophyte X 740.

*Explanation of figures 41-43
(*Predaea feldmannii*)*

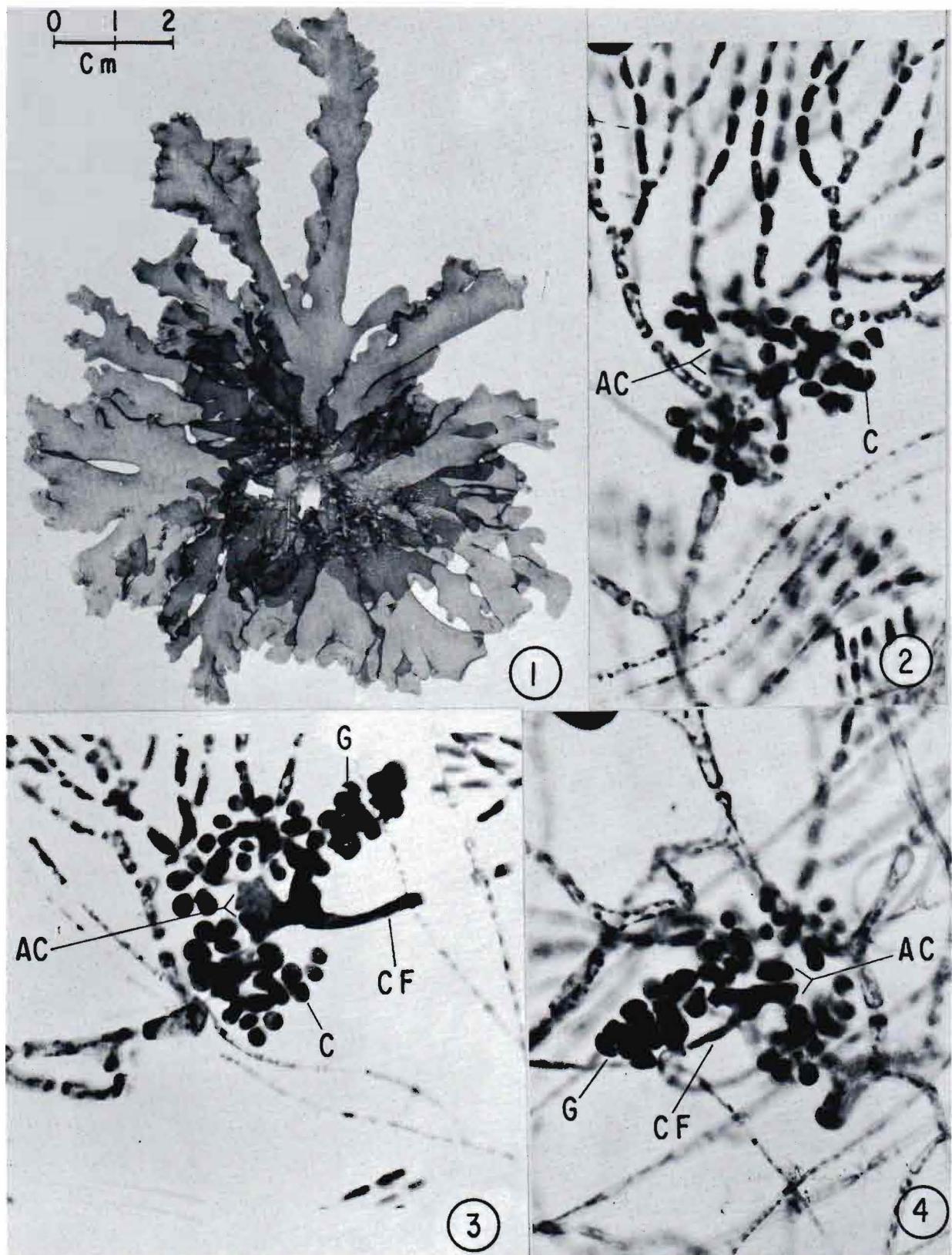
- Fig. 41. Origin of branched, septate connecting filaments from the fertilized carpogonium. Note the first formed connecting filament in the form of an isodiametric cell.
Fig. 42. Part of a tetrasporophyte with a young tetrasporangial initial in the centre and *in situ* germination of a tetraspore within the sporangium toward the right.
Fig. 43. Part of a tetrasporophyte with 2 mature tetrasporangia.

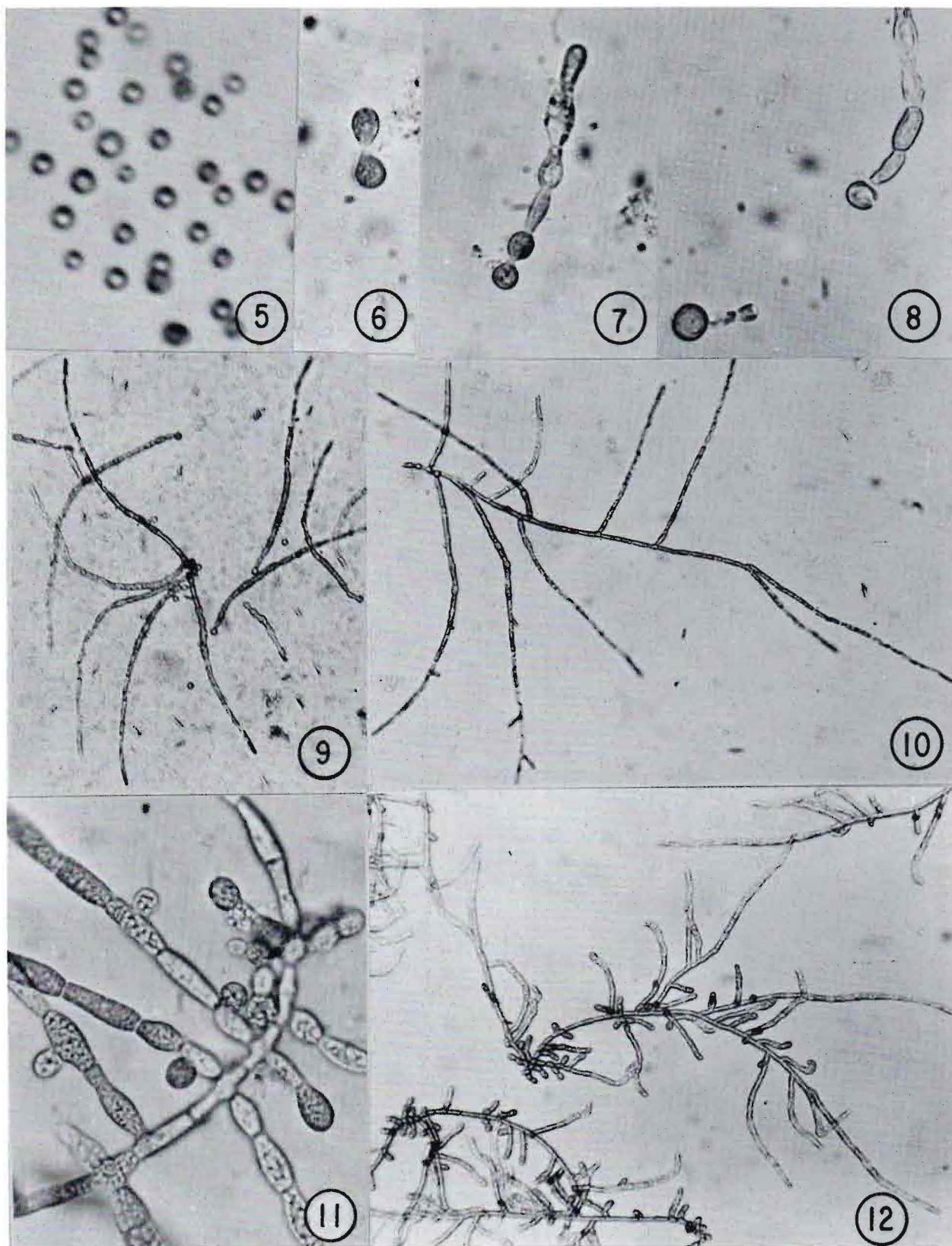
*Explanation of figures 44-51
(*Predaea pusilla*)*

- Fig. 44. Cortical filament with a young auxiliary cell above and a developing carpogonial branch below.
Fig. 45. A fully developed carpogonial branch.
Fig. 46. A developing auxiliary cell. Note the initiation of 'celulles' below and above the auxiliary cell.
Figs. 47-48. Two fully differentiated auxiliary cells.
Figs. 49-50. Origin of branched connecting filaments from the fertilized carpogonium.
Fig. 51. Terminal initiation of gonimoblast from the auxiliary cell.

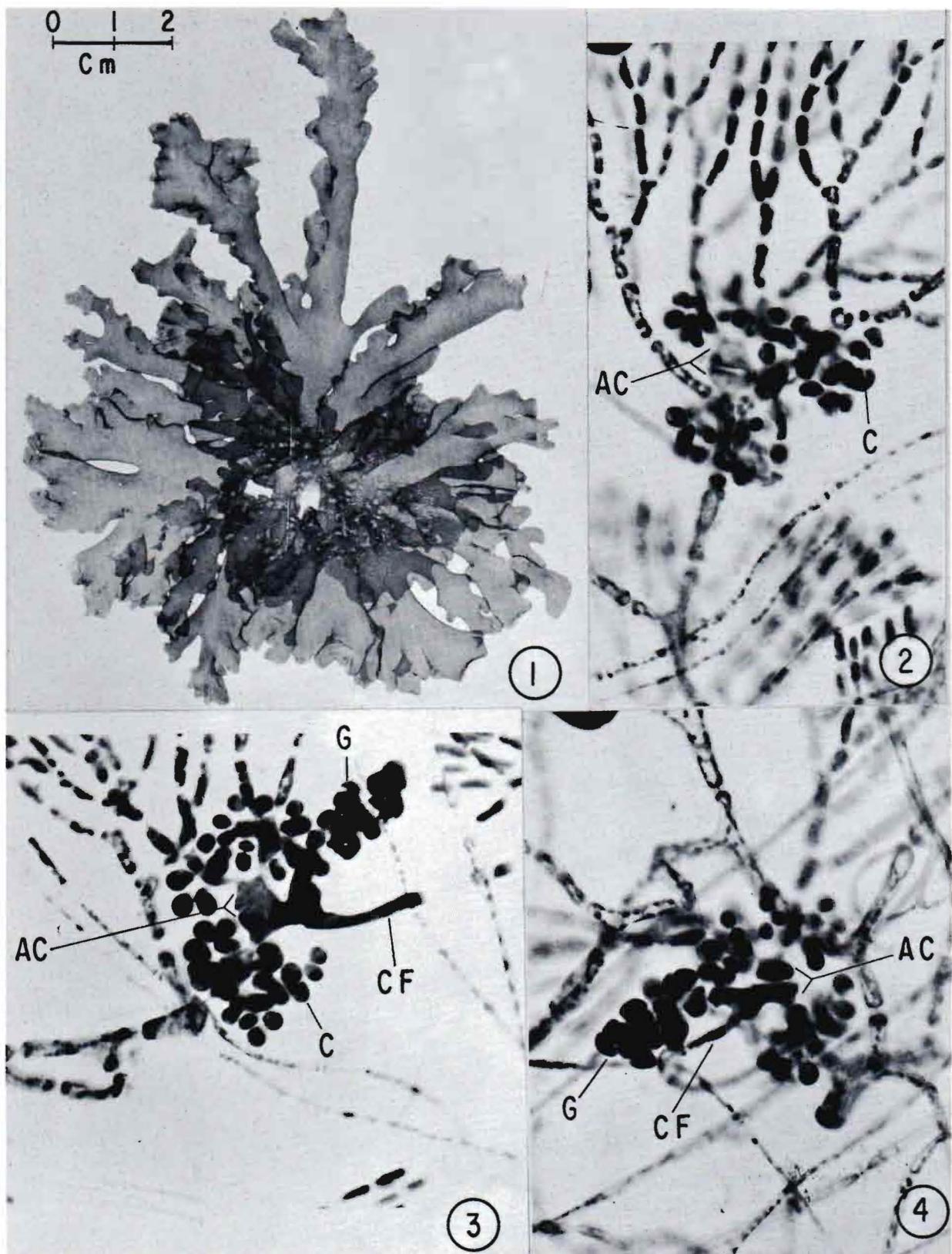
Explanation of abbreviations used in figures

AC=Auxiliary cell. C=Celulles. CF=Connecting filament. CP=Carpogonium. CP 1=First cell of carpogonial branch. CP 2=Hypogynous cell. G=Gonimoblast. GI=Gonimoblast initial. FC=Fertilized carpogonium. SP=Spermatangium. T=Tetrasporangium. TR=Trichogyne.

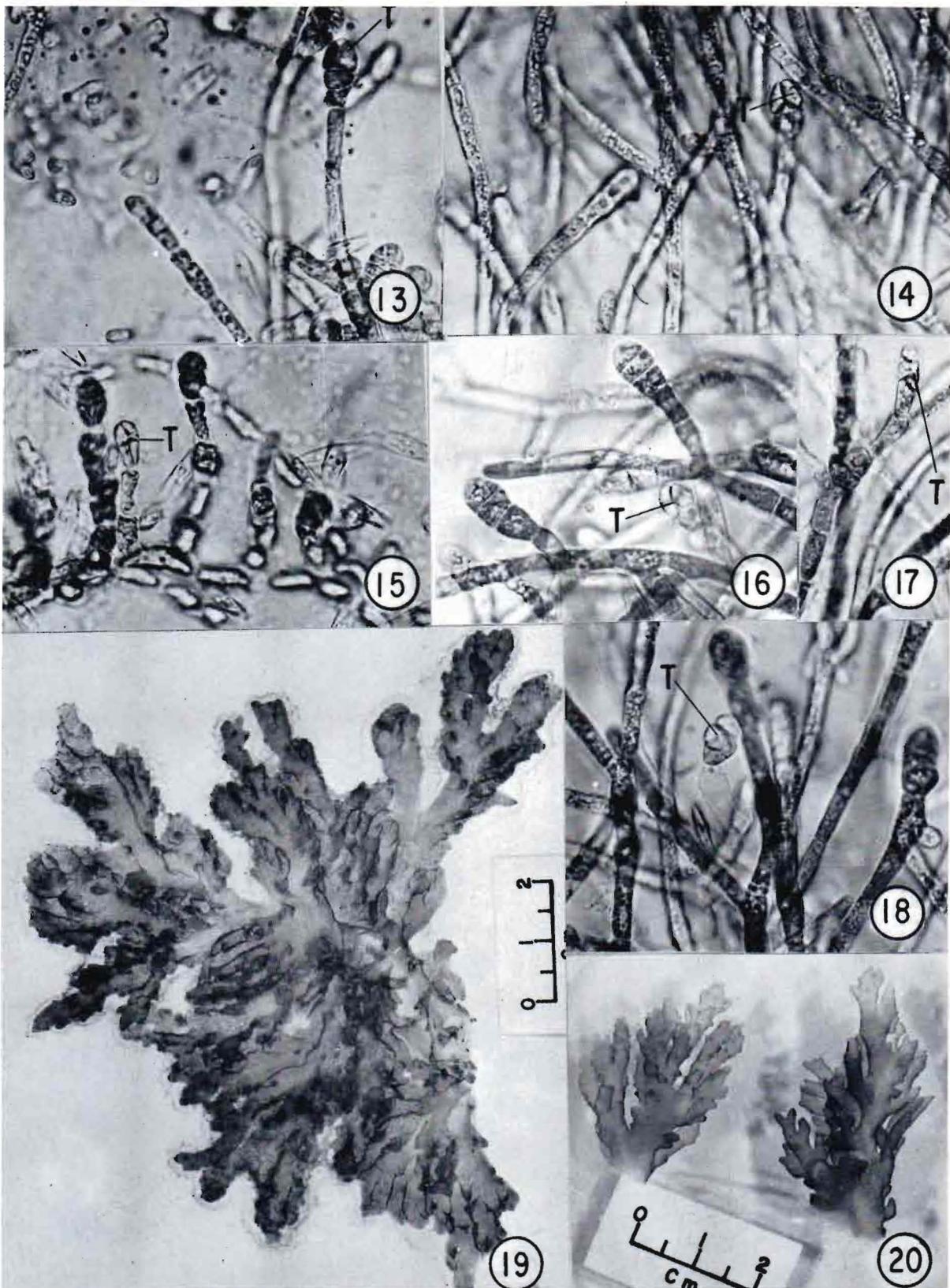


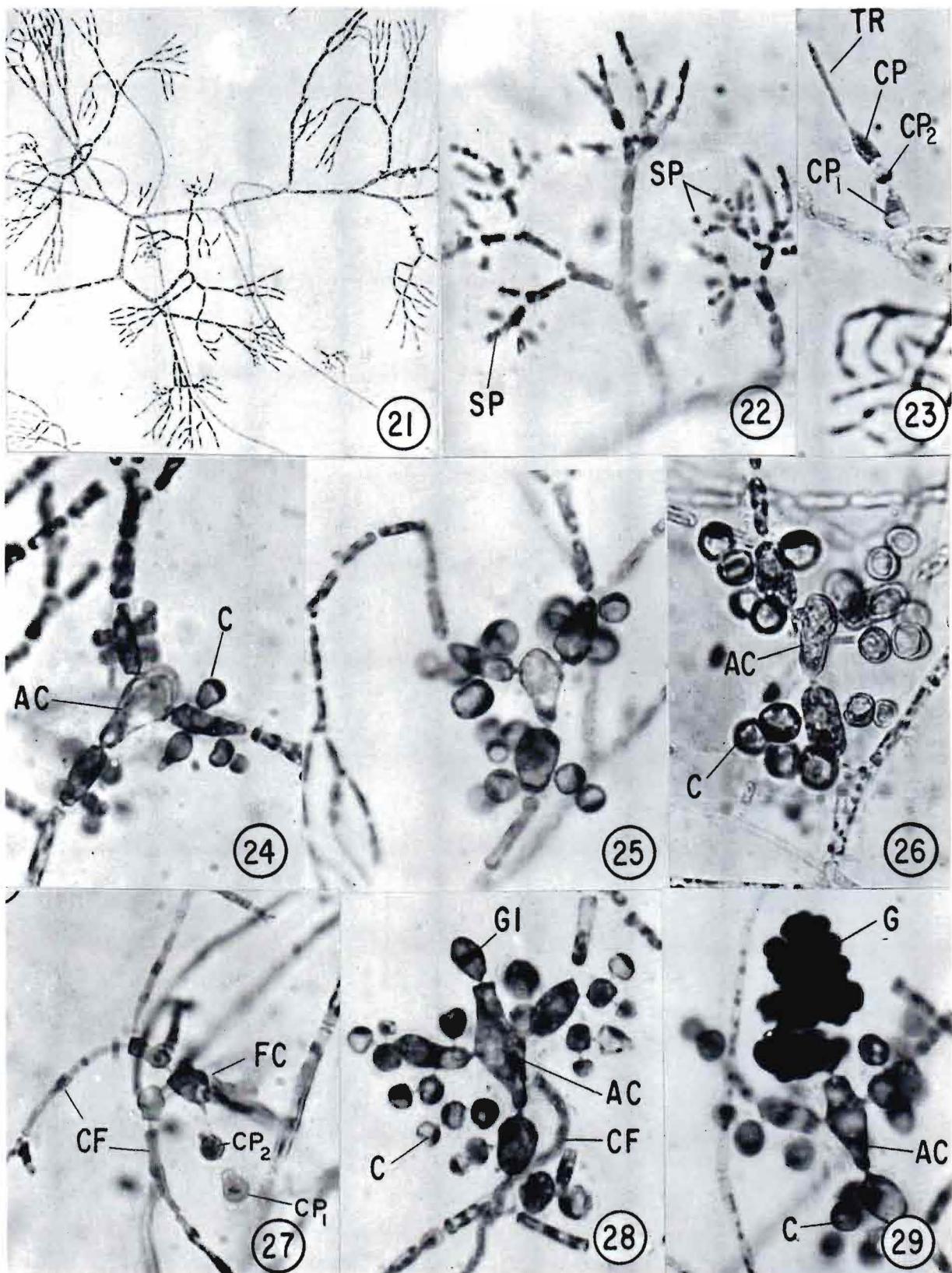


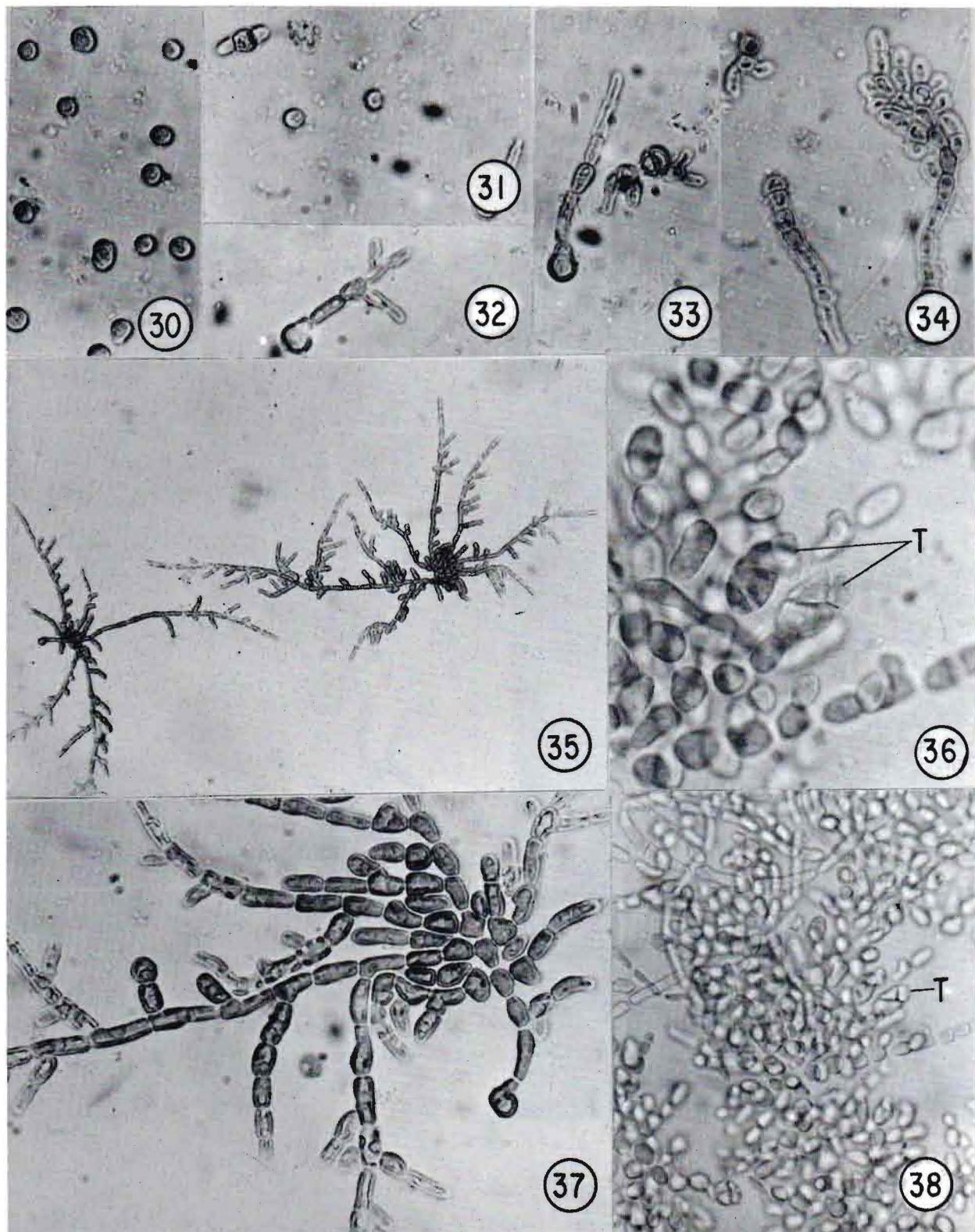
Studies in two species of *Predaea* G. De Toni

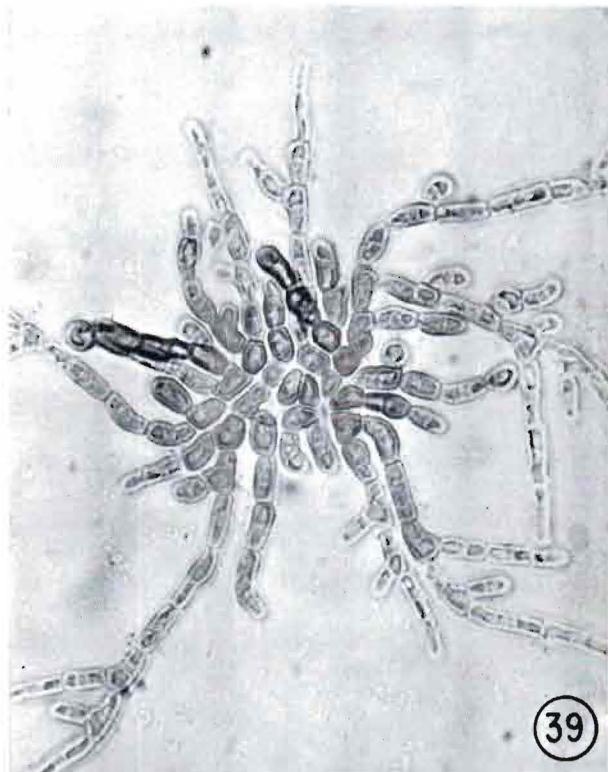


Studies in two species of *Predaea* G. De Toni

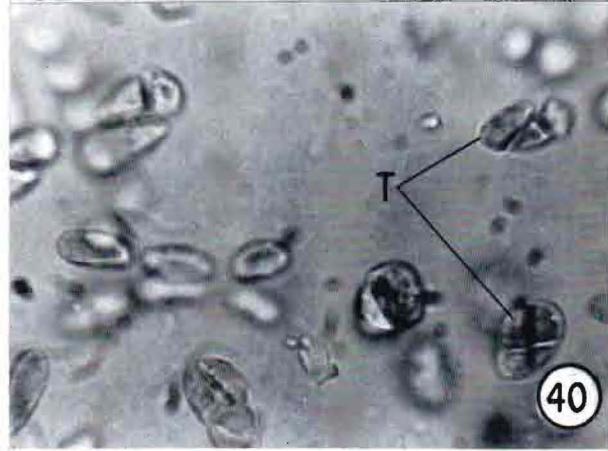








39



40

