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INTERTIDAL AND PHYCOPHILOUS FUNGI FROM TENERIFE (CANARY ISLANDS)

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(With 8 Text-figures)

Seventeen ascomycetes and four fungi imperfecti collected on Tenerife represent the first records of marine fungi from the Canary Islands. The majority occurred on wood, three species were associated with algae, two were found in foam along the shore, and one lived in the shells of balanids. The most frequently collected species were *Microthelia maritima* (Linder) Kohlm., *Ceriosporopsis halima* Linder, and *Torpedospora radiata* Meyers. The new combination *Banhegyia uralensis* (Naoumoff) is proposed.

Our knowledge about geographical distribution of higher marine fungi is still limited. While ample collections have been made along the coasts of the U.S.A., in the Mediterranean and along European Atlantic coasts, no marine fungi were known from the African Atlantic coast or nearby islands until recently when some halophilic fungi from Liberia were described (Kohlmeyer, 1966*b*).

In November 1964 I had the opportunity to collect marine fungi on Tenerife, one of the Canary Islands. The following list indicates the frequency of occurrence of twenty-one wood-inhabiting or phycophilous ascomycetes and deuteromycetes on the shores of Tenerife. Collections were made mainly on the north coast of the island (Puerto de la Cruz and San Juan de la Rambla); some samples were taken on the southern shore at El Medano.

The material was examined and determined immediately after collecting. A thorough investigation was made 2 weeks later in the laboratory of the Botanical Museum, Berlin–Dahlem. The collection is deposited in the 'Mycotheca marina' in Berlin–Dahlem.

Ordinary fountain-pen ink ('Pelikan', blue) was used in these investigations to demonstrate ascospore appendages. Setae and gelatinous appendages were stained within a few seconds and kept the stain after the surrounding ink was washed out of the preparation with water. Ascospores of *Lulworthia* stained blue and both end chambers were readily differentiated. Apical apparatuses of asci of certain species could also be stained with ink.

ASCOMYCETES

1. *BANHEGYIA URALENSIS* (Naoumoff) Kohlm. comb.nov.

Bas.: *Celidium proximellum* (Nyl.) Karst. var. *uralensis* Naoumoff, *Bull. Soc. mycol. Fr.* **30**, 384, figs. 6–8, 1914.

Syn.: *Banhegyia setispora* Zeller & Tóth, *Sydowia* **14**, 326–328, figs. 1 *a–c*, 1960.

Hab.: on decorticated driftwood (conifer) with empty shipworm tunnels, Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2258; associated fungi: *Microthelia maritima* (Linder) Kohlm. and *Zalerion maritimum* (Linder) Anastasiou.

This fungus was first found by Naoumoff (1914, 1915) on bark of *Juniperus communis* L. in the Ural mountains (Perm district, Russia). Later, it was collected four times on the same substrate in the Bükk mountains (Hungary) by Zeller & Tóth (1960) who described it as a new genus and species. Müller & Arx (1962) have found the species in the Alps, likewise on *J. communis*. The substrate of our collection might also be *Juniperus*. Two species of this genus occur on the Canary Islands, viz. *J. cedrus* Webb. & Berth. and *J. phoenicea* L.

Zeller & Tóth correctly assigned the fungus to a genus of its own, but, unfortunately, were not aware of the earlier publication by Naoumoff. Thus a new combination is necessary.

The following description of *B. uralensis* is based on material from Tenerife. Ascomata disk-shaped, 240–460 μ diam, dark-brown, developing within the substrate, then erumpent (Fig. 1). Hymenium first covered by a crust of brown cells which crumble away, finally widely exposed. Hypothecium hyaline to light brown, merging into a bowl-shaped, dark-brown layer surrounding the hymenium, the dark layer merging below into a long cone-shaped base rooted in the wood. Cells of hypothecium and stalk composed of isodiametrical cells. Excipulum light-brown, laterally thick, becoming thinner towards margin and base, composed of large, isodiametrical, partly rounded cells (Fig. 1). Pseudoparaphyses 70–86 μ long, rising above the asci and forming a brown epithecium, septate, each with a dark, apical inflation, 4–7 μ diam (Fig. 4). Asci 8-spored, clavate, short-stalked, thick walled especially at the apex, bitunicate; ectoascus staining blue with iodine or ink (Fig. 3), 55–83 × 15–20 μ (Fig. 2). Ascospores elliptical, 2-celled, constricted at the centrally located septum, hyaline to light-brown, 15–27 × 6·5–9 μ, with four to six radiating setae about 12 μ long (Figs. 5–8) at each end.

The setae are not seen on spores within the ascus. They probably develop by fragmentation of the exospore and unfold in the manner described for the setae of *Herpotrichiella ciliomaris* Kohlmeyer (1960), a pyrenomycete with similar ascospores. In older spores, the setae are deciduous (Zeller & Tóth, 1960). They may become bent while being mounted on microscope slides (Figs. 7 and 8).

The collection from Tenerife differs from Zeller & Tóth's description in some minor respects. In the material from Hungary and also in Naoumoff's collection the fungus had developed on bark of *Juniperus* while the

Tenerife fungus was growing on decorticated wood. Dr E. Müller informed me that his material from the Alps was also on naked wood. Zeller & Tóth do not mention the cone-shaped foot of the ascomata (Fig. 1), which may, however, be poorly developed in some specimens. The asci in my collection are short-pedicillate attaining a maximal length of 83 μ, while Zeller & Tóth describe the asci as sessile and up to 48 μ long. Finally, ascomata from Tenerife are larger in diameter than those from Hungary, which were only 120–240 μ.

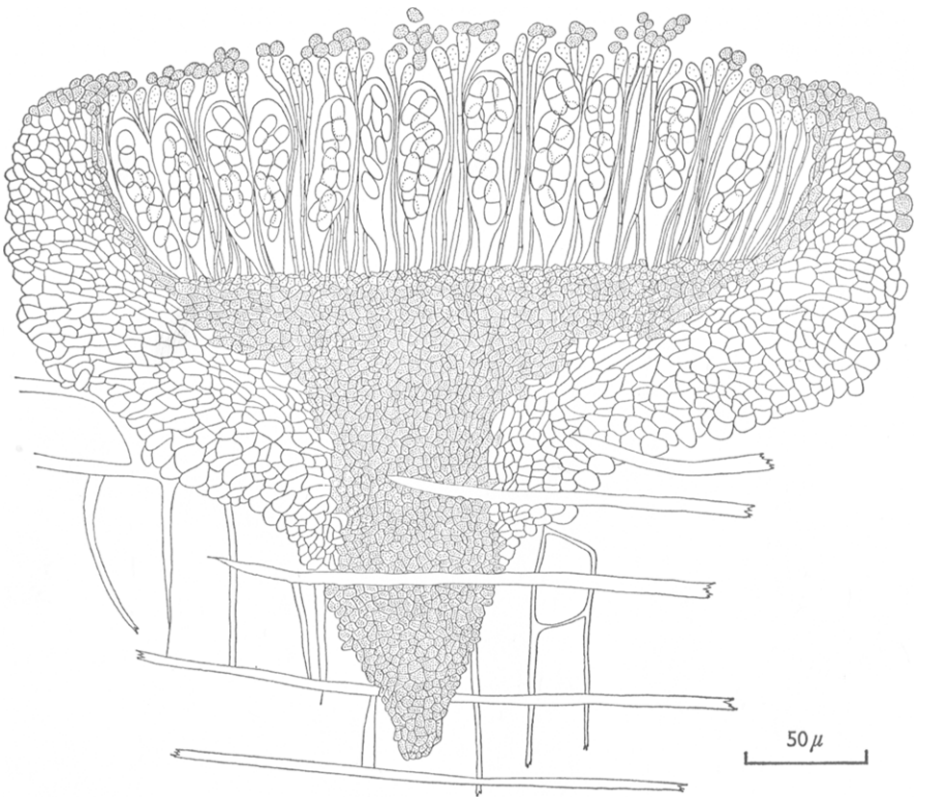
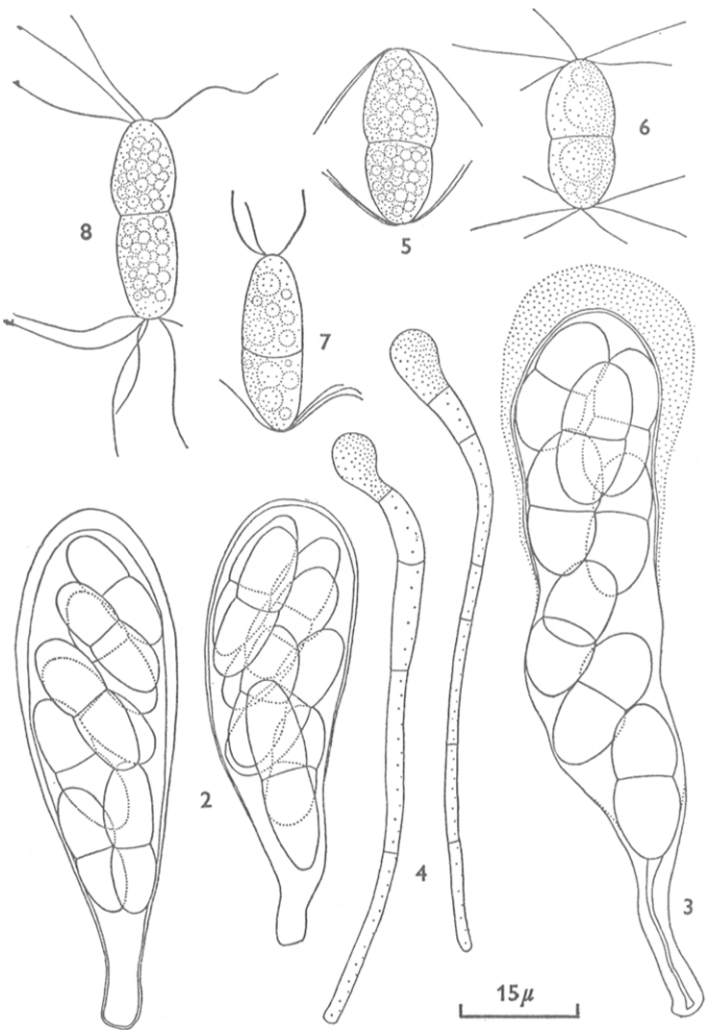


Fig. 1. *Banhegyia uralensis*. Median section.

The descriptions by Naoumoff (1914, 1915) and Müller & Arx (1962) do not contribute any further aspects to the circumscription of the species, which was extensively described by Zeller & Tóth. The differences between the Hungarian and the Tenerife material may be due to development under extremely different conditions and do not warrant the erection of a new species for the collection from the Canary Islands. Other collections of this species from the marine habitat must be awaited to learn more about its variability.

Banhegyia uralensis resembles a discomycete but has bitunicate asci. It belongs to the Patellariaceae in the Dothiorales (cf. Müller & Arx, 1962). In this family, we now know two species from the marine environment, namely *B. uralensis* and *Buellia haliotrepha* J. & E. Kohlmeyer (1965).

In conclusion, the question arises whether *B. uralensis* can be considered a marine fungus. The fact that this species developed in the intertidal region on wood in empty shipworm tunnels, close to the two typical marine fungi *Microthelia maritima* and *Zalerion maritimum* would suffice to classify *B. uralensis* as a marine species, according to the definition given elsewhere (J. & E. Kohlmeyer, 1964). Since, however, it is not restricted to the marine habitat it should be grouped as a facultative marine fungus.



Figs. 2–8. *Banhegyia uralensis*. Fig. 2. Asci. Fig. 3. Stretched ascus; ectoascus especially thick in the apex, stained with iodine. Fig. 4. Pseudoparaphyses. Figs. 5–8. Ascospores; 5, appendages unfolding; 7–8, appendages bent in mounting.

2. *Cerioporopsis halima* Linder

Hab.: on driftwood, Puerto de la Cruz, 26 November to 10 December 1964, Herb. J. K. no. 2232, 2236–9, 2249, 2250.

This species, which is one of the most common fungi in the sea, was collected twelve times on Tenerife. However, it ranked only second in frequency after *Microthelia maritima*.

3. *Chaetosphaeria chaetosa* Kohlm.

Hab.: on driftwood and on hollow stem of a shrub, San Juan de la Rambla, 29 November 1964, Herb. J. K. nos. 2225–8.

The species was found four times, but only in one locality on the north coast of Tenerife. Earlier collections were made in Bulgaria (Black Sea), on the Atlantic north coast of Spain (Kohlmeyer, 1963*b*), and in Massachusetts (Kohlmeyer, unpublished).

Setae of ascospores as well as apical plates of asci readily stain blue in ink.

4. *Corollospora maritima* Werdermann

Hab.: on driftwood, Puerto de la Cruz, 26 November, 2 and 11 December 1964, Herb. J. K. nos. 2231, 2232, 2252; in seawater-foam on the shore, El Medano, 3 December 1964.

This arenicolous marine fungus, which was collected four times, has a world-wide distribution. The occurrence of this and other sand-inhabiting species can easily be demonstrated by microscopic examinations of foam samples taken along the shore (Kohlmeyer, 1966*a*).

5. *Corollospora trifurcata* (Höhnk) Kohlm.

Hab.: in seawater-foam on the shore, El Medano, 3 December 1964.

This species was found only in foam. Extensive sampling of foam along coasts of other countries would probably reveal that *C. trifurcata* is more widely distributed than the present sparse reports indicate.

6. *Haligena elaterophora* Kohlm.

Hab.: on driftwood, Puerto de la Cruz, 26 November 1964, Herb. J. K. no. 2240.

This rarely collected fungus is known from the Pacific northwest of the U.S.A., the Spanish Atlantic coast, and the German coast of the North Sea. The collection from Tenerife is the southernmost one so far. The gelatinous cover of young ascospores and the apical, expanded appendages stain well in ink. The asci dissolve early, while the pseudoparenchymatous cell chains of the centre remain intact after the perithecia are crushed. Some asci have only four ascospores, which are larger than the spores from eight-spored asci. The ascospores measure (26–)29–40·5 × (11·5–)13–19·5 μ. Normally, ascospore diameter does not exceed 17·5 μ (J. & E. Kohlmeyer, 1964).

7. *Halosphaeria appendiculata* Linder

Hab.: on driftwood, Puerto de la Cruz, 24 November 1964, Herb. J. K. no. 2236.

Ascospores and appendages stain blue after short treatment with ink.

8. *Leptosphaeria oraemaris* Linder

Hab.: on driftwood, Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2239.

Ascospores 17·5–21 × 5–6 μ, one- and three-septate.

9. *Lulworthia kniepii* Kohlm.

Hab.: on *Lithophyllum* sp., Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2260.

This fungus, which has been reported only from the Mediterranean (Kohlmeyer, 1963*a*), occurs rather frequently on Tenerife. The mycelia and immersed perithecia form black spots on the lower side of living thalli.

10. *Lulworthia* sp.

Hab.: on corn cob (*Zea mays* L.), Puerto de la Cruz, 11 December 1964, Herb. J. K. no. 2263; on driftwood, same location, 4 December 1964, Herb. J. K. no. 2237.

The cob had apparently been submerged in the sea for some time and bears black perithecia immersed and on the surface. Ascospores from this collection are 360–390 μ long. Ascospores from driftwood are 335–370 μ long, 3·5–4·5 μ diam at the middle and 2·5–3 μ diam at the ends; the end chambers are 4·5–6 μ long. Both collections seem to belong to one species closely related to *L. medusa* (Ell. & Everh.) Cribb & Cribb. An assignment to species cannot be made until a thorough revision of the genus *Lulworthia* Sutherl. is carried out.

11. *Microthelia maritima* (Linder) Kohlm.

Hab.: on driftwood (conifer), Puerto de la Cruz, 26 November to 11 December 1964, Herb. J. K. nos. 2243–5, 2251, 2258.

Sixteen samples containing *M. maritima* were collected. The high proportion of conifer wood among the driftwood may account for the frequent occurrence of this species on the shores of Tenerife; my earlier collections of the fungus were also mainly on hard, resin-containing conifer wood. The ascospore sizes, more variable than indicated in earlier recordings (J. Kohlmeyer & E. Kohlmeyer, 1964), are 13·5–21 × 6–7·5 μ.

Johnson & Sparrow (1961) reject the combination *M. maritima*, arguing that *Microthelia* Körber is a lichen genus, while the species in question is not lichenized. The reasons for recognizing *Microthelia* as a genus comprising lichenized as well as non-lichenized fungi are fully discussed by Müller & Arx (1962). Fruiting body structure of *M. maritima* (J. & E. Kohlmeyer, 1964/67, tab. 39) clearly indicates the close affinity of

that fungus to other species of *Microthelia* as redefined by Müller & Arx (1962).

12. *Mycophycophila corallinarum* (Crouan & Crouan) Kohlm.

Hab.: on *Corallina mediterranea* Aresch., Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2261; amongst *Epilithon membranaceum* (Esp.) Heydr., epiphytic on *Sargassum* sp., El Medano, 3 December 1964, Herb. J. K. no. 2262.

Ascospores and appendages stain blue in ink. The ascospores measure 12–16 × 4·5–6 μ (without appendages). The species was previously found as an epiphyte on seven different hosts (Kohlmeyer, 1963*a*). Collection no. 2262 is remarkable in that the perithecia occur among and on *Epilithon* thalli. Earlier collections of ascomata on *Halimeda*, *Corallina*, and *Udotea* were also frequently covered by epiphytic algae (e.g. *Dermatolithon*; Kohlmeyer, 1963*a*). This joint occurrence of fungus and epiphytic alga appears to be more than accidental. *Mycophycophila polyporolithi* Bonar, morphologically very similar to *M. corallinarum*, is also associated with epiphytic, calcareous algae (Bonar, 1965). It is possible that *M. corallinarum* has a symbiotic relationship with these epiphytic algae. The fungus and the alga may form a sort of primitive lichen in which at least one partner, the alga, can live independently from the other.

13. *Nautosphaeria cristaminuta* Jones

Hab.: on driftwood, San Juan de la Rambla, 29 November 1964, Herb. J. K. no. 2225.

Ascospores in this collection as well as in earlier ones (Kohlmeyer, 1963*b*) were hyaline. Jones (1964) described the ascospores as hyaline but becoming grey or fuscous at maturity. The tufts of bristle-like ascospore appendages stain blue in ink. This species was previously known only from the type locality (Isle of Man, Britain), from the Mediterranean, and from the Atlantic coast of Spain.

14. *Pharcidia balani* (Winter) Bauch, *Pubbl. Staz. zool. Napoli* **15**, 379, 1936

Syn.: *Epicymatia balani* Winter, in Hariot, *J. Bot., Paris* **1**, 233–234, 1887.
Ostracoblabe implexa Bornet & Flahault, *Bull. Soc. bot. Fr.* **36**, clxxi–clxxii, 1889: a possible synonym (Keissler, 1937; Santesson, 1939).
Pharcidia marina Bommer, *Bull. Soc. belge Microsc.* **17**, 151, 1891.
Didymella conchae Bonar, *Univ. Calif. Publs. Bot.* **19**, 188, 1936.
Didymella balani (Winter) Feldmann, *Trav. Stn biol. Roscoff* Suppl. **6**, 136, 1954.
Melanopsamma balani (Winter) Meyers, *Mycologia* **49**, 485, 1957.

Hab.: in shells of *Chthamalus stellatus stellatus* (Poli), Puerto de la Cruz, 11 December 1964, Herb. J. K. no. 2259.

This organism frequently occurs as a facultative symbiont with various species of algae (Feldmann, 1937; Santesson, 1939) and may be recog-

nized as the lichen *Arthopyrenia sublitoralis* (Leight.) Arnold. It is listed here, however, under the name of the fungus, because a symbiotic relationship with algae cannot always be determined with certainty. Shells of marine animals may harbour embedded ascomata without any detectable gonidia nearby (Santesson, 1939).

The earliest description of the fungus is that of Winter, 1887. Bauch transferred the species to *Pharcidia* Körber, this genus having priority over *Epicymatia* Fuck. (see Müller & Arx, 1962). Later transfers by Feldmann in 1954 and Meyers in 1957 (see citations above) are not justified because *Didymella* Sacc. belongs to the Pseudosphaeriales, and *Melanopsamma* Niessl is synonymous with *Chaetosphaeria* Tul. (see Müller & Arx, 1962). Moreover, representatives of the last-named genus have thin-walled asci with apical plates, while the asci in *P. balani* are thick-walled and lack apical apparatuses.

The systematic position of the genus *Pharcidia* is not clear. Janex-Favre (1965) prefers its inclusion in the Ascoloculares, close to both Mycosphaerellaceae and Pleosporaceae. Developmental studies of *P. balani* are needed to determine the final position of this species.

Santesson (1939) cites further synonyms for the lichen name *A. sublitoralis*. There may be additional fungus and lichen synonyms as indicated in the discussion of 'fungus-alga associations' by Johnson & Sparrow (1961).

Pharcidia balani was apparently collected earlier on Tenerife, according to Santesson (1939) who lists *Arthopyrenia sublitoralis* on *Patella guttata*.

In my material the fungus has the following dimensions; Ascomata 220–320 μ diam, 160–180 μ high; asci 60–85 × 20–21 μ; ascospores 18–21·5 × 6·5–8·5 μ. Walls of the unitunicate asci are 6·5–9 μ thick at the apex. Iodine stains plasma and ascospores brown, while the ascus walls remain unstained. No apical apparatus is detectable.

Black, ostiolate pycnidia (or spermogonia?), 120–160 μ diam, develop between the larger ascomata and may be mistaken for young perithecia. Conidiophores, 10–15 μ long, cover the inner wall of the pycnidia. The hyaline pycnidiospores (or spermatia?) are oval, 2·5 × 1·3 μ, and catenulate.

Illustrations of *P. balani* have been published in the fourth fascicle of *Icones fungorum maris* (J. & E. Kohlmeyer, 1964/67).

15. *Remispora quadriremis* (Höhnk) Kohlm.

Hab.: on driftwood, Puerto de la Cruz, 27 November to 11 December 1964, Herb. J. K. nos. 2241, 2242, 2250, 2251.

This universally distributed, common species was collected six times. The ascospore appendages stain blue in ink.

16. *Thalassoascus tregoubovii* Ollivier

Hab.: on *Cystoseira fimbriata* (Desf.) Bory, Puerto de la Cruz, 2 and 8 December 1964, Herb. J. K. nos. 2253, 2255; on *C. abiesmarina* (Turner) C.Ag., same location, 2 December 1964, Herb. J. K. no. 2256; on *C. fimbriata*, San Juan de la Rambla, 29 November 1964, Herb. J. K.

no. 2257; on *C. discors* C.Ag., El Medano, 3 December 1964, Herb. J. K. no. 2254.

Heretofore, *Thalassoascus tregoubovii* was found only in the Mediterranean (Kohlmeyer, 1963*a*). One collection of the fungus on *Dilophus fasciola* (Roth) Howe from the western part of the English Channel (Aleem, 1952) may represent a variety.

The ascospores in collection no. 2253 on *C. fimbriata* measure 34–42 × 22·5–28·5 μ; in collection no. 2254 on *C. discors* they are 29–45·5 × 18·5–31·5 μ; hence *T. tregoubovii* displays a greater variation in ascospore size than was recorded earlier (Kohlmeyer, 1963*a*). Combined ascospore sizes of present and earlier collections are 29–48 × 18·5–33·5 μ.

Samples nos. 2253 and 2254 contain mature, stalked ascomata, up to 1·75 mm high, developed on the bases of the algae. While ostioles were lacking in fruiting bodies on *Cystoseira* from the Mediterranean (Kohlmeyer, 1963*a*), ascomata from Tenerife have distinct ostiola with periphyses. The apical walls of the ascomata consist of densely entwined, branched hyphae 3·5–4·5 μ diam, which probably dissolve to form the pore. The lateral parts of the wall are composed of irregular, polygonal, partly rounded, thick-walled cells.

The ascospores in collection no. 2254 are covered by a hyaline, gelatinous sheath which shrinks, giving the spores a granular or nearly alveolar outer texture. Whether this is an artifact in this particular collection or the natural development of an ectospore is not certain.

On all samples from Tenerife cited above pycnidia (or spermogonia) had developed on the algal bases. In no. 2253 they are attached to the base of ascomatal stalks. Hence, it can be assumed, that this imperfect state belongs to *T. tregoubovii*. In no. 2254 hyaline, oval to ovoid conidia (or spermatia), about 3–4 × 2–3 μ, are pressed out of the pycnidial ostioles. Collections nos. 2255 to 2257 on *C. abiesmarina* and *C. fimbriata* contain only pycnidia. In sample no. 2255 these black, sessile structures (Kohlmeyer, 1963*a*, pl. 4, fig. 16) are 150–180 μ diam; the conidiophores are 25 × 2–2·7 μ. The globose to oval conidia are 2–3·5 × 4 μ. Pycnidia in no. 2256 are up to 350 μ diam.

17. *Torpedospora radiata* Meyers

Hab.: on driftwood and bamboo, San Juan de la Rambla, 26 November 1964, Herb. J. K. nos. 2227, 2228; Puerto de la Cruz, 26 November to 11 December 1964, Herb. J. K. nos. 2232–4, 2249, 2252; El Medano, 3 December 1964, Herb. J. K. no. 2235.

In our collections from Tenerife, this species ranks third in frequency after *Microthelia maritima* and *Ceriosporopsis halima*. Ascospore appendages stain blue in ink.

FUNGI IMPERFECTI

18. *Cirrenalia macrocephala* (Kohlm.) Meyers & Moore

Hab.: on driftwood, Puerto de la Cruz, 26 November 1964, Herb. J. K. nos. 2245–7.

Two of the wood samples are invaded by *Limnoria*, one sample by teredinids.

19. *PHOMA* sp.

Hab.: on driftwood, associated with *Chaetosphaeria chaetosa*, San Juan de la Rambla, 29 November 1964, Herb. J. K. no. 2229.

20. *ZALERION MARITIMUM* (Linder) Anast.

Hab.: in empty shipworm tunnels on driftwood, Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2258.

21. Cf. *ZALERION VARIUM* Anast.

Hab.: on driftwood, Puerto de la Cruz, 27 November 1964, Herb. J. K. no. 2248.

This fungus is close to *Z. varium*, however, it could not be identified with certainty because it did not grow in pure culture. Brown conidia consist of irregularly shaped cell complexes.

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