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PHYTOPLANKTON ORGANISMS OF THE ARABIAN SEA OFF THE WEST COAST OF INDIA*

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APPLIED aspects of marine fisheries research have considerably suffered in India owing to the lack of a proper taxonomical appraisal of the minute plant organisms occurring in the water which are the prime synthesizers of all food matter in the sea and also form the food of a large number of small animals, important links in the food chain,[†] and of some fishes of commercial importance. An account for the Diatoms (Bacillariophyceæ), one class of the algal organisms, was published by the writer in 1946 with descriptions and figures of over 170 forms, from the east coast of India. With the inauguration of the Central Marine Fisheries Research Station, opportunity was available to continue the studies on the Bacillariophyceæ as well as other phytoplankton organisms, the Dinophyceæ, Myxophyceæ, Silicoflagellata, Coccolithineæ and so on. Work was also taken up with reference to their ecology, quantitative abundance over the seasons, magnitude of production of matter by them and the factors responsible for the production, in addition to a taxonomical study. Accounts of these studies are under preparation and will be published later. In this note the organisms recorded during the course of a five years' study are listed.

The diatoms with 226 species constitute the major portion of the phytoplankton as regards variety and bulk of occurrence; the Dinophyceæ come next with 121 forms and except for *Noctiluca miliaris* Suriray, none of the other species contribute to the bulk generally, though some species at certain times occur in such large quantities as to discolour the sea-water. e.g., *Ornithocercus magnificus* and *Gymnodinium* sp. Species of *Trichodesmium* (Myxophyceæ) occur in large quantities at certain times floating on the surface of the water, while the Chloromonadineæ, *Hornellia marina*, occurs in enormous numbers

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to discolour the water green and causes mortality of fishes often (Subrahmanyam, 1954 *b*). The Euglenineæ, *Protoeuglena noctiluca* is found in large numbers inside *Noctiluca* and when this *Noctiluca* occurs in swarms, the water is coloured green (Subrahmanyam, 1954 *a*). The species of the remaining classes of algæ are sparsely represented.

Many of the Bacillariophyceæ recorded here, about 150 species of them, have been found on the east coast also (Subrahmanyam, 1946). Over 90% of the total number of species of all other classes listed here are new records for the country.

A few of the important references used in the identification of the species may be cited here: Hustedt (1930-32), Cleve-Euler (1951-55), Schmidt's Atlas (1874-1928) and Subrahmanyam (1946) for the Bacillariophyceæ; Schiller (1933-37) for the Dinophyceæ and Schiller (1930) for the Coccolithineæ; Gemeinhardt (1930) for the Silicoflagellatæ; Geitler (1932) for the Myxophyceæ (Cyanophyceæ); Gojdics (1953) and Subrahmanyam (1954 *a*) for the Euglenineæ; and Pascher (1913), Huber-Pestalozzi (1950) and Subrahmanyam (1954 *b*) for the Chloromonadineæ.

I should like to record here my thanks to Dr. N. K. Panikkar for his keen interest in the investigations.

LIST OF THE PHYTOPLANKTON ORGANISMS†

Bacillariophyceæ

- | | |
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| 1. <i>Melosira sulcata</i> (Ehrenb.) Kütz. | 22. <i>C. lineatus</i> Ehrenb. |
| 2. <i>Podosira montagnei</i> Kütz. | 23. <i>C. sub-lineatus</i> Grun. |
| 3. <i>Hyalodiscus subtilis</i> Bailey | 24. <i>C. stellaris</i> Roper |
| 4. <i>Pyxidicula minuta</i> Grunow | 25. <i>C. rothii</i> var. <i>subsalsa</i> (Juhl.—
Dannf.) Hustedt |
| 5. <i>Stephanopyxis turris</i> (Grev. et Arn.)
Ralfs | 26. <i>C. marginatus</i> Ehrenb.— |
| 6. <i>S. palmeriana</i> (Grev.) Grun. | 27. <i>C. radiatus</i> Ehrenb. |
| 7. <i>Skeletonema costatum</i> (Grev.)
Cleve | 28. <i>C. granii</i> Gough |
| 8. <i>Porosira glacialis</i> (Grun.) Jörg. | 29. <i>C. granii</i> var. <i>aralensis</i> (Osterf.
Hustedt) |
| 9. <i>Coscinosira polychorda</i> Grun | 30. <i>C. jonesianus</i> (Grev.) Ostenf. |
| 10. <i>Thalassiosira decipiens</i> (Grun.)
Jörg. | 31. <i>C. jonesianus</i> var. <i>commutata</i>
(Grun.) Hustedt |
| 11. <i>T. hyalina</i> (Grun.) Grun | 32. <i>C. concinnus</i> W. Smith |
| 12. <i>T. baltica</i> (Grun.) Ostenf. | 33. <i>C. schimperii</i> Karsten |
| 13. <i>T. kryophilæ</i> (Grun.) Jörg. | 34. <i>C. centralis</i> Ehrenb. |
| 14. <i>T. coramandeliana</i> Subrahmanyam | 35. <i>C. perforatus</i> Ehrenb. |
| 15. <i>T. subtilis</i> (Ostenf.) Grun. | 36. <i>C. perforatus</i> var. <i>pavillardi</i> (Forti)
Hustedt |
| 16. <i>T. nana</i> Lohmann | 37. <i>C. apiculatus</i> Ehrenb. |
| 17. <i>Cyclotella meneghiniana</i> Kütz. | 38. <i>C. asteromphalus</i> Ehrenb. |
| 18. <i>C. striata</i> (Kütz.) Grun. | 39. <i>C. oculus-iridis</i> Ehrenb. |
| 19. <i>Ethmodiscus gazellæ</i> (Janisch)
Hustedt | 40. <i>C. oculus-iridis</i> var. <i>borealis</i>
(Bailey) Cleve |
| 20. <i>Coscinodiscus excentricus</i> Ehrenb. | 41. <i>C. gigas</i> var. <i>prætexta</i> (Janisch)
Hustedt |
| 21. <i>C. excentricus</i> var. <i>fasciculata</i>
Hustedt | |

† The forms are arranged in their taxonomic order.

Bacillariophyceæ—(Contd.)

42. *C. janischii* A. Schmidt
 43. *Planktoniella sol* (Wallich) —
 Schütt
 44. *Actinoptychus undulatus* (Bailey)
 Ralfs
 45. *Asteromphalus robustus* Castracane
 46. *A. flabellatus* (Bréb.) Grev.
 47. *A. cleveanus* Grunow
 48. *A. wyvillei* Castracane
 49. *Aulacodiscus orbiculatus*
 Subrahmanyan
 50. *Gossleriella tropica* Schütt
 51. *Auliscus sculptus* (W. Smith) Ralfs
 52. *Actinocyclus ehrenbergii* Ralfs
 53. *A. tenuissimus* Cleve
 54. *Bacterosira fragilis* Gran
 55. *Corethron hystrix* Hensen
 56. *C. inerme* Karsten
 57. *Lauderia annulata* Cleve
 58. *Schröderella delicatula* (Perag.)
 Pav.
 59. *Leptocylindrus danicus* Cleve
 60. *L. minimus* Gran
 61. *L. adriaticus* Schröder?
 62. *Guinardia flaccida* (Castr.) Perag.
 63. *G. blavyana* Perag.
 64. *G. victorie* Karsten
 65. *Rhizosolenia fragilissima* Bergon
 66. *R. firma* Karsten
 67. *R. cylindrus* Cleve
 68. *R. stouterfothii* H. Perag.
 69. *R. robusta* Norman
 70. *R. imbricata* Brightwell
 71. *R. imbricata* var. *shrubslei* (Cleve)
 Schröder
 72. *R. styliformis* Brightwell
 73. *R. styliformis* var. *latissima* Bright-
 well
 74. *R. styliformis* var. *longispina*
 Hustedt
 75. *R. setigera* Brightwell
 76. *R. hebetata* var. *semispina* (Hensen)
 Gran
 77. *R. calcaravis* M. Schultze
 78. *R. crassispina* Schröder
 79. *R. alata* Brightwell
 80. *R. alata* f. *gracillima* (Cleve) Grun.
 81. *R. alata* f. *indica* (Perag.) Ostenf.
 82. *R. alata* f. *inermis* (Castr.) Hustedt.
 83. *R. acuminata* (Perag.) Gran
 84. *R. castracanei* Perag.
 85. *R. castracanei* var. *rhomboidea*
 Subrahmanyan
 86. *Bacteriastrum minus* Karsten
 87. *B. delicatulum* Cleve
 88. *B. hyalinum* Lauder
 89. *B. hyalinum* var. *princeps* (Castr.)
 Ikari
 90. *B. varians* Lauder
 91. *B. elongatum* Pav.
 92. *B. mediterraneum* Pav.
 93. *B. elegans* Pav.
 94. *B. comosum* Pav.
 95. *Chaetoceros atlanticum* var. *neo-*
 politana (Schütt) Hustedt
 96. *C. eibenii* Grun.
 97. *C. coarctatus* Lauder
 98. *C. tetrastichon* Cleve
 99. *C. danicus* Cleve
 100. *C. borealis* Bailey
 101. *C. denticulatum* Lauder
 102. *C. peruvianus* Brightwell
 103. *C. peruvianus* var. *robusta* (Cleve)
 Hustedt
 104. *C. decipiens* Cleve
 105. *C. mitra* (Bailey) Cleve
 106. *C. lorenzianus* Grun.
 107. *C. indicus* Subrahmanyan
 108. *C. lauderi* Ralfs
 109. *C. compressus* Lauder
 110. *C. didymus* Ehrenb.
 111. *C. didymus* var. *protuberans*
 (Lauder) Gran et Yendo
 112. *C. didymus* var. *heterosetoides*
 Subrahmanyan
 113. *C. constrictus* Gran
 114. *C. van Heurckii* Gran
 115. *C. affinis* Lauder
 116. *C. affinis* var. *intermedius*
 Subrahmanyan
 117. *C. paradoxum* Cleve
 118. *C. laciniosus* Schütt
 119. *C. pelagicus* Cleve
 120. *C. brevis* Schütt
 121. *C. holštaticus* Schütt
 122. *C. diversus* Cleve
 123. *C. lævis* Leud.-Fort.
 124. *C. ralfsii* Cleve
 125. *C. messanensis* Castracane
 126. *C. wighamii* Brightwell
 127. *C. fragilis* Meunier
 128. *C. curvisetus* Cleve
 129. *C. debilis* Cleve
 130. *C. tortissimus* Gran
 131. *C. socialis* Lauder
 132. *C. simplex* Ostenf.
 133. *C. myriapodus* Mangin
 134. *Eucampia zodiacus* Ehrenb.
 135. *E. cornuta* (Cleve) Grun.
 136. *Climacodium frauenfeldianum*
 Grunow
 137. *C. biconcavum* Cleve
 138. *Streptotheca indica* Karsten
 139. *Bellerophon malleus* (Brightwell)
 van Heurck
 140. *Ditylum brightwellii* (West) Grun.
 141. *D. sol* Grun.
 142. *Lithodesmium undulatum* Ehrenb.
 143. *Triceratium favus* Ehrenb.
 144. *T. robertsonianum* Grev.

Bacillariophyceæ—(Contd.)

145. *T. dubium* Brightwell
 146. *T. reticulatum* Ehrenb.
 147. *T. cternans* Bailey
 148. *Biddulphia pulchella* Gray
 149. *B. sinensis* Grev.
 150. *B. mobiliensis* Bailey
 151. *B. heteroceros* Grun.
 152. *B. japonica* Castracane
 153. *B. rhombus* (Ehrenb.) W. Smith
 154. *B. aurita* (Lyngb.) Bréb.
 155. *B. longicuris* Greville
 156. *Isthmia enervis* Ehrenb.
 157. *Cerataulina bergoni* Perag.
 158. *Hemiaulus hauckii* Grun.
 159. *H. sinensis* Grev.
 160. *H. membranaceus* Cleve
 161. *Hemidiscus hardmannianus* (Grev.) Mann
 162. *Rhabdonema mirificum* W. Smith
 163. *Striatella delicatula* (Kütz.) Grun.
 164. *Grammatophora undulata* Ehrenb.
 165. *Licmophora abbreviata* Agardh
 166. *L. debilis* (Kütz.) Grun.
 167. *Climacosphenia moniligera* Ehrenb.
 168. *C. elongata* Bailey
 169. *Fragilaria oceanica* Cleve
 170. *Raphoneis amphiceros* Ehrenb.
 171. *R. discoides* Subrahmanyman
 172. *Synedra formosa* Hantzsch
 173. *Thallassionema nitzschoides* Grun.
 174. *Thallassiothrix longissima* Cleve et Grun.
 175. *T. frauenfeldii* Grun.
 176. *T. antarctica* Schimper
 177. *Asterionella japonica* Cleve
 178. *Cocconeis sigmoides* Subrahmanyman
 179. *C. littoralis* Subrahmanyman
 180. *Achnanthes strömii* Hustedt
 181. *Mastogloia exilis* Hustedt
 182. *M. minuta* Grev.
 183. *Gyrosigma balticum* (Ehrenb.) Rabenh.
 184. *Pleurosigma capense* Karsten
 185. *P. galapagense* Cleve
 186. *P. elongatum* W. Smith
 187. *P. normani* Ralfs
 188. *P. angulatum* (Quekett) W. Smith
 189. *P. angulatum* var. *strigosa* (W. Smith) van Heurck
 190. *P. aestuarii* Bréb.
 191. *P. carinatum* Donkin
 192. *P. directum* var. *membranacea* Subrahmanyman
 193. *Pleurosigma* sp. ‡
 194. *Caloneis madraspatensis* Subrahmanyman
 195. *Diploneis weissflogii* (A. Sch.) Cleve
 196. *D. puella* (Schumann) Cleve
 197. *D. fusca* var. *subrectangularis* Cleve
 198. *D. smithii* (Bréb.) Cleve
 199. *D. robustus* Subrahmanyman
 200. *Navicula longa* (Greg.) Ralfs
 201. *N. hennedyii* W. Smith
 202. *N. hennedyii* var. *nebulosa* (Greg.) Cleve
 203. *N. clavata* Gregory
 204. *N. forcipata* Greville
 205. *N. membranacea* Cleve
 206. *Pinnularia alpina* W. Smith
 207. *Trachyneis aspera* var. *genuina* Cleve
 208. *T. antillarum* Cleve
 209. *Amphiprora gigantea* var. *sulcata* (O'Meara) Cleve
 210. *Tropidoneis semistriata* Grun.
 211. *Amphora lineolata* Ehrenb.
 212. *A. decussata* Grun.
 213. *A. ostrearia* Bréb.
 214. *A. pusio* Cleve
 215. *Cymbella marina* Castracane
 216. *Bacillaria paradoxa* Gmelin
 217. *Nitzschia pelagica* Karsten
 218. *N. panduriformis* var. *continua* Grun.
 219. *N. vitrea* Norman
 220. *N. sigma* var. *indica* Karsten
 221. *N. closterium* (Ehrenb.) W. Smith
 222. *N. longissima* (Bréb.) Ralfs
 223. *N. seriata* Cleve
 224. *Surirella fluminensis* Grun.
 225. *S. eximia* Grev.
 226. *Campylodiscus iyengarii* Subrahmanyman

Dinophyceæ

227. *Haplodinium* sp. ‡¹
 228. *Haplodinium* sp. ‡²
 229. *Desmocapsa* sp. ‡
 230. *Exuviaella compressa* Osterfeld
 231. *Prorocentrum micans* Ehrenb.
 232. *P. micans* var. ‡
 233. *P. sigmoides* Böhm.
 234. *Phalacroma rotundatus* (Clap. et Lachm.) Kof. et Mich.
 235. *P. dolychopterigium* Murray et Whitting
 236. *Dinophysis ovum* Schütt

‡ The forms marked with ‡ appear to be new taxa and will be described with their Latin diagnoses in a later paper.

Dinophyceæ—(Contd.)

237. *D. acuminata* Clap. et Lachm.
 238. *D. caudata* Saville-Kent.
 239. *D. caudata* f. *acutiformis* Kof. et Skoggsberg
 240. *D. miles* f. *indica* Ostenf. et Schmidt
 241. *Amphisolenia elongata* Kof. et Skoggsberg
 242. *A. bidentata* Schröder
 243. *Ornithocercus magnificus* Stein s. str. Schütt
 244. *Parahistoneis rotundata* Kof. et Mich.
 245. *Oxyrrhis marina* Dujardin
 246. *Amphidinium extensum* Wulff.
 247. *Gymnodinium* sp. †¹
 248. *G. gelbum* Kof.
 249. *G. marinum* Saville-Kent.
 250. *G. mirabile* f. †
 251. *G. splendens* Lebour
 252. *G. uberrimum* (Allman) Kof. et Swezy
 253. *G. variabile* C. E. Herdman
 254. *Gymnodinium* sp. †²
 255. *Gymnodinium* sp. †³
 256. *Massartia glauca* (Lebour) Schiller
 257. *Gyrodinium aureum* Conrad
 258. *G. citrinum* Kof.
 259. *G. fusiforme* Kof. et Swezy
 260. *G. lingulifera* Lebour
 261. *G. obtusum* (Schütt) Kof. et Swezy
 262. *G. pepo* (Schütt) Kof. et Swezy
 263. *G. pingue* (Schütt) Kof. et Swezy
 264. *G. spirale* (Bergh) Kof. et Swezy
 265. *Polykrikos schwartzii* Butschli
 266. *Noctiluca miliaris* Suriray
 267. *Paulsenella chaetoceratis* (Paulsen) Chatton
 268. *Sphaerodinium* sp. †¹
 269. *Sphaerodinium* sp. †²
 270. *Pyrophacus horologicum* Stein
 271. *P. horologium* var. *steinii* Schütt
 272. *Glenodinium lenticula* f. *asymmetrica* (Mangin) Schiller
 273. *G. pilula* (Ostenf.) Schiller
 274. *G. trochoideum* Stein
 275. *Peridinium bulla* Meunier
 276. *P. hyalinum* Meunier
 277. *P. minutum* Kof.
 278. *P. thorianum* Paulsen
 279. *P. excentricum* Paulsen
 280. *P. globulus* Stein
 281. *P. globulus* var. *quarnerense* Br. Schröder
 282. *P. globulus* var. *ovatum* (Pouchet) Schiller
 283. *P. granii* Ostenf.
 284. *P. steinii* var. *mediterraneum* Kof.
 285. *P. pedunculatum* Schütt.
 286. *P. brochii* Kof. et Swezy
 287. *P. brochii* var. *inflatum* (Okamura) Schiller
 288. *P. crassipes* Kof.
 289. *Peridinium* sp. †
 290. *P. divergens* Ehrenb.
 291. *P. conicoides* Paulsen
 292. *P. conicum* (Gran) Ostenf. et Schmidt
 293. *P. conicum* f. *guardafuiana* Marz.
 294. *P. humile* Schiller
 295. *P. lecnis* f. *matzenaueri* Schillett
 296. *P. obtusum* Karsten
 297. *P. pentagonum* Gran
 298. *P. subineine* Paulsen
 299. *P. claudicans* Paulsen
 300. *P. depressum* Bailey
 301. *P. grande* Kof.
 302. *P. murrayi* Kof.
 303. *P. oceanicum* Vanl. öffen
 304. *P. venustum* Matz.
 305. *P. sinaicum* Matz.
 306. *Gonyaulax diegensis* Kof.
 307. *G. scrippsæ* Kof.
 308. *Ceratium candelabrum* f. *curvatulum* Jörg.
 309. *C. candelabrum* f. *depressum* Pouchet
 310. *C. furca* f. *eugrammum* (Ehrenb.) Jörg.
 311. *C. teres* Kof.
 312. *C. setaceum* Jörg.
 313. *C. minutum* Jörg.
 314. *C. inflatum* (Kof.) Jörg.
 315. *C. longirostrum* Gourret
 316. *C. fuscus* (Ehrenb.) Dujardin
 317. *C. fuscus* var. *seta* (Ehrenb.) Jörg.
 318. *C. dens* Ostenf. et Schiller
 319. *C. tripos* var. *atlanticum* Ostenf.
 320. *C. tripos* f. *ponticum* Jörg.
 321. *C. tripos* f. *subsalsum* Ostenf.
 322. *C. pulchellum* f. *semipulchellum* Jörg.
 323. *C. humile* Jörg.
 324. *C. breve* (Ostenf. et Schiller) Schröder
 325. *C. bucephalum* (Clevé) Cl.
 326. *C. karstenii* f. *robustum* (Karsten) Jörg.
 327. *C. gibberum* Gourret
 328. *C. lunula* Schimper
 329. *C. schmidtii* Jörg.
 330. *C. declinatum* Karsten
 331. *C. longipes* (Bailey) Gran
 332. *C. longipes* f. *balticum* Ostenf.
 333. *C. horridum* Gran
 334. *C. buceros* Zacharias s. dilet.
 335. *C. vultur* var. *sumatranum* (Karst.) Stee-Nielsen

Dinophyceæ—(Contd.)

- ✓336. *C. massiliense* f. *macroceroides* (Karsten) Jörg. ✓342. *Ceratocorys horrida* Stein
 ✓337. *C. massiliense* f. *armatum* (Karsten) Jörg. ✓343. *Podolampas bipes* Stein
 ✓338. *C. carriense* f. *volans* (Cleve) Jörg. ✓344. *P. palmipes* Stein
 ✓339. *C. macroceros* (Ehrenb.) Cl. ✓345. *Pyrocystis pseudonociluca* (Wy. Thompson) Schiller
 ✓340. *C. macroceros* var. *gallicum* (Kof.) Jörg. ✓346. *P. (Dissodinium) fusiformis* (Wy. Thomp.) Murray
 ✓341. *C. trichoceros* (Ehrenb.) Kof. 347. *P. (Dissodinium) fusiformis* f. *biconica* Kof. ✓

Chlorophyceæ

348. *Chlamydomonas* sp. ‡ 349. *Carteria* sp. ‡

Chloromonadineæ

350. *Hornellia marina* Subrahmanyana

Myxophyceæ

- ✓351. *Lyngbya aestuarii* Liebm. 355. *Katagnymeme spiralis* Lemm.
 ✓352. *Trichodesmium erythraeum* Ehrenb. 356. *Anabana* sp. ‡
 ✓353. *T. thiebautii* Gomont 357. *Richelia intracellularis* Schmidt
 354. *T. contortum* Wille

Euglenineæ

358. *Protæuglena noctiluca* Subrahmanyana 359. *Euglena* sp. ‡

Silicoflagellata

360. *Dictyocha staurodon* Ehrenb. 363. *D. fibula* var. *pentagona* Schulz
 361. *D. fibula* var. *longispina* Lemm. 364. *Distephanus speculum* (Ehrenb.) Hæckel
 362. *D. fibula* f. *rhombica* Schulz

Coccolithineæ

365. *Coccolithus pelagicus* (Wallich) Schiller 366. *Rhabdosphaera longistylis* Schiller

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