Creating a preliminary checklist for recent freshwater Japanese endemic diatom taxa

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Abstract: A checklist of recent freshwater Japanese endemic diatom taxa was compiled. 427 recent freshwater diatom taxa have been described from Japan. 122 taxa are reported only from Japan and should be endemic. 29 taxa were reported from both Japan and other East Asian countries. 204 taxa have never been used since their first description and are regarded as Practically Non-existent Species (PNS)' and omitted from the analysis.

Key words: East Asia, diatom, endemism, Japan

Introduction

Japan is a biodiversity hotspot, and many endemic species have been reported (e.g., Kato & Ebihara 2011). Understanding endemism is a core topic of biodiversity and creating checklists of endemic species is an important task for Japanese biologists, including taxonomists. The National Museum of Nature and Science (Japan) has been making checklists of endemic species including plants, algae, animals and fungi (Kato & Ebihara 2011, National Museum of Nature and Science 2018). We have also tried to make such a list for recent freshwater diatoms.

Micro-organisms like diatoms were once thought to be cosmopolitan (e.g., Vanormelingen et al. 2007). Cosmopolitanism was an implicit assumption for many diatom studies in Japan, and as a result European monographs and flora lists (e.g., Hustedt 1930, Krammer & Lange-Bertalot 1986) were regularly used to identify Japanese diatoms (e.g., Tuji 1995). However, the assumption of cosmopolitanism was rarely discussed. For example, Watanabe et al. (2005) stated that many diatoms are cosmopolitan and harvested worldwide and having the similar ecological characters as stated by Hustedt (1937). In Japan, endemism was noted for a limited number of waterbodies: highly acidic springs (e.g., Fukushima et al. 2002, Negoro 1944); and the ancient Lake Biwa (Tuji 2002, Tuji & Kociolek 2000). Country-level endemism has never been discussed. Though many new species have been described from Japanese oligosaprobic rivers (e.g., Kobayasi 1960), the possibility of them being endemic to Japan has never been discussed.

Furthermore, information on the diatom flora of neighboring nations is essential for understanding endemism of Japanese diatoms. However, no comparative studies between the flora of Japan and neighboring nations has been done. Since East Asian countries have strong economic exchanges, Japanese endemic taxa may exist as alien species in these nations. However, it is difficult to distinguish alien species from native species without old specimens. Unfortunately, we don't have such old specimens in many cases (see Tuji 2011).

To provide an exhaustive and complete analysis of diatom endemism in Japan would require the examination of types and their comparison with molecular data, but this describes the requirements for Japanese diatom studies and is unrealistic as a short-term goal. The goal of this study is to create a preliminary checklist of recent freshwater Japanese 'endemic' diatom taxa.

Materials and Methods

For creating a preliminary checklist of recent freshwater Japanese 'endemic' diatom taxa, we compiled the recent freshwater diatom taxa described from Japan, using published papers, Japanese monographs (Watanabe et al.
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2005), databases, web-based databases, DiatomBase: Kociolek et al. (2017), and Index Nominum Algarum Bibliographia Phycologica Universalis (2017) to create a checklist of recent freshwater diatoms described from Japan.

Two difficult problems arise when attempting to estimate the level of endemism in Japan. One significant problem in making this checklist, was the existence of many poorly-described taxa. Boris Vassilievich Skvortsov (= Skvortzov, Skvortzkov, Skvortsow: 1890–1980) described more than half of the total number of taxa from Japan. His descriptions, however, are very brief and his figures are often too simple to be used to identify the species with any certainty. Most species described by him have never been found after his initial first descriptions, and much of the original material, including the types, have been lost, possibly during or just after World War II. Although we have examined some of the remaining original material (Ohtsuka & Tuji 2002, Tuji 2002, Tuji & Williams 2006), it is very difficult to find and specify his specimens from these. These poorly-described taxa make it extremely difficult to identify Japanese diatoms accurately. It is also difficult to assess the endemism of species for which no actual specimens exist due to a lack of detailed illustrations, less characteristic name-bearing type specimens, or specimens without citations. To identify species that have not been reported after the first description, each taxon on the checklist was examined using the Global Biodiversity Information Facility (GBIF 2017) as well as Google (2017) to search digitized journals such as DIATOM (Japanese journal of diatomology) and most bulletins published by Japanese universities, in which many Japanese diatom flora have been described. We regarded these unused taxa as ‘Practically Non-existent Species (PNS)’ in the present study.

Another problem was the limited information on the distribution of these diatoms in neighboring regions (nations or districts; China, Korea, Taiwan, Russian Far East). In the last ten years, a dozen of important monographs have been published from these regions—China: Hu & Wei (2006), Jiaying & Qi (2014), Jiaying & Yuzao (2010), Qi (1995), Qi & Li (2004), Shi (2004), Zhixin (2013); Korea: Joh (2010, 2011, 2012a, 2012b), Joh et al. (2010), Lee (2011, 2012a, 2012b); Taiwan: Wu et al. (2011a, 2011b); Russian Far East: Medvedeva & Nikulina (2014); and a comparison of these floras with the Japanese flora is now possible. The remaining 151 taxa are possibly endemic to East Asia. Twenty-nine taxa were reported from both Japan and at least one other East Asian country. One hundred and twenty-two taxa have been reported only from Japan and can be considered endemic to Japan at the present time.

List of recent freshwater diatoms described from both Japan and other East Asian regions

Parentheses indicates the country or regions found for each taxon. ‘Russia’ means Russian Far East.

Eunotiaceae

1. Eunotia monodon var. asiatica Skvortsov, 1936, Philipp. J. Sci. 61: 18. pl. 1, f. 25, 35. pl. 2, f. 7, 31.
(China)

2. Eunotia monodon var. koreana Skvortsov, 1936, Philipp. J. Sci. 61: 18. pl. 1, f. 13, 14, 19, 20, 30, 33.
(Russia)

3. Eunotia veneris var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 22. pl. 1, f. 31.
(Russia)

Fragilariaeae

4. Hannaea arcus var. hattoriana (F.Meister) T.Ohtsuka, 2002, Diatom 18: 35.

5. Hannaea arcus var. subarcus (Iwah.) J.H.Lee in Lee et al. 1992, Diatom 7: 50.

6. Ulnaria inaequalis (H.Kobayasi) M.Idei in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 12.

7. Ulnaria pseudogaillonii (H.Kobayasi & M.Idei) M.Idei in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 12.

8. Achnanthe convergens (H.Kobayasi) H.Kobayasi, 1997, Nova Hedwigia 65: 159.

9. Achnanthes convergens H.Kobayasi ex H.Kobayasi et

Results and Discussion

We found 427 recent freshwater diatom taxa that have been described from Japan. Presently known diatoms endemic to Japan should be included among these taxa. Two hundred and four taxa of the 427 taxa have not been used after their first description. We regard these taxa as PNS and omitted these taxa from the list of endemic species. Seventeen taxa were nomenclaturally invalid taxa, and nine taxa were synonyms of other taxa. Many new species described by Hiromu Kobayasi were firstly invalid and later validated in subsequent papers. These validated nomenclatural synonyms are not counted as ‘nomenclaturally invalid taxa.’ Forty-six taxa were reported from outside of East Asia, such as North America, and should be treated as cosmopolitan taxa.

The remaining 151 taxa are possibly endemic to East Asia. Twenty-nine taxa were reported from both Japan and at least one other East Asian country. One hundred and twenty-two taxa have been reported only from Japan and can be considered endemic to Japan at the present time.
Japanese endemic diatoms

al. 1986, Diatom 2: 84–85. pl. 1, f. 1–7, 11–18, pl. 3, f. 37–43, pl. 5, f. 51–54.

(Korea, Taiwan, Russia)

9. Achnanthidium japonicum (H.Kobayasi) H.Kobayasi, 1997, Nova Hedwigia 65: 156.
\ (= Achnanthes japonica H.Kobayasi ex H.Kobayasi et al., 1986, Diatom 2: 85–86. pl. 2, f. 19–21, 27–36, pl. 4, f. 44–50, pl. 5, f. 55–58.

(Korea, Taiwan)

Cymbellaceae

10. Cymbella turgidula var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 283. pl. 2, f. 8, pl. 4, f. 4.

Lectotype (LT): Slide 30000136 in Lake Biwa Mu-

seum (LBM) (Ohtsuka & Tuji 2002, Tuji 2006).

≡ Cymbella rheophila Ohtsuka in Ohtsuka & Tuji 2002, Phycol. Res. 50: 245.

(Korea)

Gomphonemataceae

11. Gomphonema vastum Hust., 1927, Arch. Hydrobiol. 18: 166. pl. 5, f. 4.

(Russia)

12. Gomphonema pseudosphaerophorum H.Kobayasi in Ueyama & Kobayasi 1988, Proc. Ninth Int. Diat.

Symp. p. 452. f. 10–12, 25–37.

(Taiwan)

Diploneidaceae

13. Diploneis marginstriata var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 269. pl. 4, f. 3.

(China, Russia)

14. Diploneis oculata var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 31. pl. 14. f. 2.

(Russia)

Naviculaceae

15. Caloneis nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 267. pl. 2, f. 7, pl. 3, f. 9, pl. 4, f. 15.

(Korea)

16. Navicula globulifera var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 37. pl. 3, f. 10.

(Russia)

17. Navicula senjoensis H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 241–242. pl. 4, f. 23–26.

(Korea)

18. Navicula yuraensis Negoro et Gotoh ex Gotoh in Lee et al. 1994, Diatom 9: 33. pl. 2, f. 7, 8.

(Korea, Taiwan)

Pleurosigmataceae

19. Gyrosigma pseudokuetzingii H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ. ser. 4. 29: 239. pl. 8, f. 62, 63.

(Korea)

Pinnulariaceae

20. Pinnularia acidojaponica M.Idei & H.Kobayasi in Idei & Mayama 2001, Lange-Bert. -Festschr. p. 266. f. 1–29.

(Russia)

≡ Pinnularia appendiculata var. paeninsulaekoreana Skvortsov, 1936, Philipp. J. Sci. 61: 22. pl. 3, f. 12.

(China)

21. Pinnularia balfouriana var. stauroptera Skvortsov, 1936, Philipp. J. Sci. 61: 43. pl. 16, f. 15.

(China)

22. Pinnularia hildeana var. japonica H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 246–247. pl. 6, f. 44–46.

(Korea)

23. Pinnularia nobilis var. parallela Skvortsov, 1936, Philipp. J. Sci. 61: 27. pl. 4, f. 5.

(China)

24. Pinnularia variata var. capitata H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ. ser. 4. 29: 247. pl. 6, f. 47, 48.

(Korea)

25. Pinnularia platycephala var. hattoriana F.Meister, 1914, Arch. Hydrobiol. Planktonk. 9: 228. pl. 8, f. 6, 7.

(China)

Sellaphoraceae

27. Stauroneis staurolineata var. japonica H.Kobayasi & Kaz.Ando, 1978, Jpn. J. Phycol. 26: 15–16. pl. 2, f. 18–20.

(Korea)

Surirellaceae

28. Surirella capronii var. obtusa Hust., 1927, Arch. Hydrobiol. 18: 170. f. 2.

(Russia)

29. Surirella pantocsekii F.Meister, 1914, Arch. Hydrobiol. Planktonk. 9: 230, 231. pl. 8, f. 14, 15.

(Russia)

List of recent freshwater diatoms endemic to Japan

Aulacoseiraceae

1. Aulacoseira subarctica var. longispina (Hust.) Tuji & Houki, 2004, Bull. Natl. Sci. Mus., Ser. B. 30: 38–39.

≡ Melosira longispina Hust. in Huber-Pestalozzi 1942, Binnengew. Einzeld. Limn. Nachb. 16(2 : 2): 388. pl. 115, f. 469a.

≡ Aulacoseira longispina (Hust.) Simonsen, 1979, Bacill. 2: 61.

2. Aulacoseira subarctica var. tenuis (Hust.) Tuji & Houki, 2004, Bull. Natl. Sci. Mus., Ser. B. 30: 39.

≡ Melosira longispina var. tenuis Hust. in Huber-Pestalozzi 1942, Binnengew. Einzeld. Limn. Nachb. 16(2 : 2): 389. pl. 115, f. 469b.

≡ Aulacoseira longispina var. tenuis (Hust.) Simonsen, 1979, Bacill. 2: 61.

3. Aulacoseira nipponica (Skvortsov) Tuji, 2002, Phycol. Res. 50: 315.

≡ Melosira solida var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 255. pl. 1, f. 1, 2, 21.

LT. TNS-AL-53965 in TNS (Department of Botany, National Museum of Nature and Science) (Tuji 2002, 2006).
Biddulphiaceae
4. *Terpsinoe muninensis* Tuji, 2018, Mem. Natl. Mus. Nat. Sci. 52; 6–10. f. 1–29.

Stephanodiscaceae
5. *Cyclostephanos costatilimbus* (H.Kobayasi & Kobayashi) Stoermer et al., 1987, Brit. Phycol. J. 22: 357.
6. *Stephanodiscus costatilimbus* H.Kobayasi & Kobayashi, 1986, Jpn. J. Phycol. 34: 8–9. f. 1–13.

Discoasteria nipponica* (Skvortsov) Tuji & D.M.Williams, 2006, Bull. Natl. Sci. Mus., Ser. B. 32: 11.
7. *Cyclotella glomerata* f. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 13. pl. 1, f. 12.
8. Stephanodiscus aakanensis Tuji et al., 2003, Bull. Natl. Sci. Mus., Ser. B. 29: 2, f. 1–5.
9. Praestephanos suzukii (Tuji & Kociolek) Tuji in Tuji et al. 2014, Plankt. Benthos Res.

Thalassiosiraceae
10. *Eunotia pseudosoresanensis* Tosh.Watan., 2004, Diatom 20: 168. f. 14–19.
11. *Eunotia pseudovalida* Mayama, 1997, Nova Hedwigia Beih. 65: 168. f. 17–31.
12. *Eunotia raphidioides* Tosh.Watan., 2004, Diatom 20: 168. f. 8–13.
13. *Eunotia septentrionalis* var. intermedia Negoro, 1944, Sci. Rep. Tokyo Bunr. Daig. sec. B. 6: 319.
14. *Eunotia sparsistratia* Mayama, 1993, Nova Hedwigia Beih. 106: 144. f. 1–3, 6–19.
15. *Eunotia subalpina* Hirano et Iwaki, 1973, Bull. Fuji Women’s Coll. ser. II 11: 99. pl. 8.f. 4–5.
16. *Eunotia tenelloides* H.Kobayasi, Kaz.Ando & Nagumo, 1981, Proc. Sixth Symp. Rec. Foss. Diat. p. 97–98. pl. 3, f. 18–26.

Fragilariaeae
17. *Fragilaria asterionelloides* Tuji & D.M.Williams, 2017, Bull. Natl. Mus. Nat. Sci., ser. B 43: 46–47. f. 1, 2, 5–18.
18. *Fragilaria parasitica* var. asterionelloides F.Meister, 1914, Arch. Hydrobiol. Planktonk. 9: 227. pl. 8, f. 4.
19. *Opephora okadae* Skvortsov, 1936, Philipp. J. Sci. 61: 15. pl. 12. f. 6.
20. *Opephora martyi* var. okadae (Skvortsov) Okuno, 1952, Atlas Diat. Jpn. Diat. Dep. p. 39.

Tabellariaceae
21. *Tabellaria pseudofossulosa* H.Kobayasi ex Mayama in Kobayasi et al. 2006, H. Kobayasi’s Atlas. Jpn. Diat. p. 9, pl. 112.

Bacillariaceae
22. *Nitzschia heidenii* (F.Meister) Hust. in Schmidt et al. 1924, Atlas Diat.-kunde. pl. 351, f. 9–13.
23. *Nitzschia moissacensis* var. heidenii F.Meister, 1914, Arch. Hydrobiol. Planktonk. 9: 229. pl. 8, f. 10.

Cocconeidaceae
24. *Cocconeis disculus* var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 262. pl. 4, f. 16.

Achnanthidaceae
25. *Achnanthidium ovatum* Tosh.Watan. & Tuji in Watanabe et al. 2008, Diatom 24: 34. f. 2–25.

Cocconeidaceae
26. *Cocconeis disculus* var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 262. pl. 4, f. 16.

LT: Slide 30000142 in Lake Biwa Museum (LBM) (Ohtsuka & Tuji 2002).

Cymbellaceae
27. *Cymbella amphioxys* var. delicatissima Hirano, 1978, Study Reps. Baika Jr. Coll. 27: 111. pl. 1, f. 15.
28. *Cymbella lata* var. nipponica Skvortsov, 1936, Philipp. J. Sci. 61: 283. pl. 3, f. 6.
29. *Cymbella nipponica* Skvortsov, 1936, Philipp. J. Sci. 61: 283. pl. 5, f. 20, 23.
30. *Cymbella perpusilla* var. lanceolata Hirano, 1972, Cont. Biol. Lab. Kyoto Univ. 24: 29.

Gomphonemataceae
31. *Gomphonema okunoi* Tuji, 2005, Bull. Natl. Sci. Mus.,
43. *Gomphonema tetrastigmatum* (Okuno) Ohtsuka, 2002, Diatom *18*: 32.

44. *Gomphonema curvipedatum* H.Kobayasi ex K.Osada in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 10. pl. 122.

45. *Gomphonema kinokawaensis* H.Kobayasi ex K.Osada in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 10–11. pl. 125.

46. *Gomphonema parvulum* var. *neosaprophilum* H.Kobayasi ex K.Osada in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 11–12. pl. 135.

47. *Gomphonema yakuensis* Tuji & Tosh.Watan. in Watanabe et al. 2008, Diatom *24*: 34. f. 113–121.

48. *Gomphonema yamatoensis* H.Kobayasi ex K.Osada in Kobayasi et al. 2006, H. Kobayasi’s Atlas Jpn. Diat. p. 58.

**Rhoicospheniaceae**

49. *Gomphosphania biwaensis* Ohtsuka & D.Nakai in Ohtsuka et al. 2018, Diat. Res. *33*: 108. f. 4–22. 27–30.

50. *Gomphosphania ryukyuensis* Tuji & Ohtsuka in Ohtsuka 2016, Algae Aquae Dulcis Jpn. Exs. *VII*: no. 121, f. 1–18.

**Achnanthaceae**

51. *Achnanthes hauckiana* var. *densistriata* Horikawa & Okuno in Okuno 1940, J. Sci. Hiroshima Univ., ser. B 2–4: 52. f. 20.

**Amphipleuraceae**

52. *Frustulia rhomboidea* var. *shiretokensis* Fukush. & Kishimoto, 1968, J. Yokohama City Univ., ser. C-58: 10. pl. 4. f. M.

**Diploneidaceae**

53. *Diploneis aokiensis* M.Idei, 2013, Diat. Res. *28*: 2. f. 1–3. 10–17.

54. *Diploneis aokiensis* M.Idei & H.Kobayasi, 1984, Jpn. J. Phycol. *32*: 97. (nom. nud.)

55. *Diploneis linearifera* M.Idei, 2013, Diat. Res. *28*: 8–10. f. 7–9. 42–58.

56. *Diploneis yamanakaensis* M.Idei & H.Kobayasi, 1984, Jpn. J. Phycol. *32*: 97. (nom. nud.)

57. *Diploneis yamatoensis* Horikawa & Okuno in Okuno 1944, Bot. Mag. *58*: 8. f. 3a.

58. *Diploneis clementis* var. *nipponica* (Skvortzov) Ohtsuka in Ohtsuka & Tuji 2002, Phycol. Res. *50*: 249.

59. *Navicula similis* var. *kipponica* Skvortsov, 1936, Philipp. J. Sci. *61*: 276. pl. 3. f. 2.

60. *Luticola nipponica* (Skvortsov) Tuji, 2003, Bull. Natl. Sci. Mus., Ser. B. *29*: 67.

61. *Navicula mutica* var. *nipponica* Skvortsov, 1936, Philipp. J. Sci. *61*: 270. pl. 4. f. 10.

**Naviculaceae**

62. *Caloneis clevei* var. *minor* H.Kobayasi, 1975, Bull. Tokyo Gakugei Univ. ser. 4. *27*: 181. pl. 2. f. 23–26.

63. *Geissleria pusilla* Tuji, 2016, Algae Aquae Dulcis Jpn. Exs. *VII*: no. 123, f. 1–6.

64. *Navicula biwaensis* (Skvortsov) Ohtsuka in Ohtsuka & Tuji 2002, Phycol. Res. *50*: 249.

65. *Navicula rostellata* biwensis Skvortsov, 1936, Philipp. J. Sci. *61*: 272. pl. 3. f. 14.

66. *Navicula delicatilineolata* H.Kobayasi & Mayama in Mayama 2003, Diatom *19*: 168–170. f. 14–19.

67. *Navicula brehmii* Hust., 1927, Arch. Hydrobiol. *18*: 163. pl. 5. f. 6.

68. *Navicula clementis* var. *japonica* H.Kobayasi, 1968, Jpn. J. Bot. *20*: 105. pl. 4. f. 54–56.

69. *Navicula cremorne* var. *salinarum* Negoro & Gotoh, 1983, Acta Phytot. Geobot. *34*: 92. f. 1D–F.

70. *Navicula delicatilineolata* H.Kobayasi & Mayama in Mayama 2003, Diatom *19*: 19–21. f. 11–20.

71. *Navicula elevata* H.Kobayasi, 1968, Jpn. J. Bot. *20*: 106. pl. 4. f. 44–46.

72. *Navicula eleginensis* var. *cuneata* H.Kobayasi, 1975, Bull. Tokyo Gakugei Univ., ser. 4. *27*: 188–189. pl. 4. f. 54–55.

73. *Navicula exiloides* H.Kobayasi & Mayama in Mayama 2003, Diatom *19*: 17–19. f. 1–10.

74. *Navicula fushimiensis* Okuno, 1974, Diatm. Elektroeenmkr. *9*: 21. pl. 875, 876.

75. *Navicula koidzumiana* (Skvortsov) Tuji, 2011, Bull. Natl. Sci. Mus., Ser. B. *37*: 113.

76. *Cymbella koidzumiana* Skvortsov, 1971, Sci. Rep. Nii-gata Univ., ser. D. *8*: 20. pl. 3. f. 9.

77. *Navicula longistriata* Horikawa & Okuno in Okuno 1940, J. Sci. Hiroshima Univ. ser. B. 2–4: 5. 60. f. 33.

78. *Navicula pseudobrasiliana* Tuji, 2003, Bull. Natl. Sci. Mus., Ser. B. *29*: 69. pl. 6. f. 6–12.

79. *Navicula pseudocrucicula* H.Kobayasi, 1975, Bull. Tokyo Gakugei Univ., ser. 4. *27*: 189–190. pl. 4. f.
59–62.
77. Navicula schonfeldii var. capitata H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 241. pl. 5, f. 40–43.
78. Navicula subdicephala Hust., 1927, Arch. Hydrobiol. 18: 64. pl. 5, f. 9.
79. Navicula subhasta Ohtsuka in Ohtsuka & Tuji 2002, Phycol. Res. 50: 246.
≡ Navicula hasta var. gracilis Skvortsov, 1936, Philipp. J. Sci. 61: 275. pl. 7, f. 9.
80. Navicula subtrrophicatrix Tuji, 2003, Bull. Natl. Sci. Mus., Ser. B. 29: 70. pl. 5, f. 8–15.
81. Navicula tanakae Fukush. et al., 2002, Diatom 18: 16. f. 1–110.
82. Navicula tokyoensis H.Kobayasi, 1968, Jpn. J. Bot. 20: 109. pl. 5, f. 73, 74. pl. 8, f. 116.
83. Navicula undulata Skvortsov, 1936, Philipp. J. Sci. 61: 275. pl. 4, f. 2, pl. 7, f. 6.
≡ Navicula hasta var. undulata (Skvotsov) H.Kobayasi in Mayama et al. 2002, Diatom 18: 89.
84. Navicula watanabei Fukush. et al., 2014, Jpn. J. Water Treat. Biol. 50: 33. f. 55–57.

Neidiaceae
85. Neidium minus Tosh.Watan. et al. ex Tuji 2016, Algae Aquae Dulcis Jpn. Exs. VII: 9. no. 124. f. 1–6.
86. Neidium nipponicum f. rostratum H.Kobayasi in Kobayasi & Ando 1975, Bull. Tokyo Gakugei Univ., ser. 4. 27: 191–192. pl. 3, f. 34, 36.
87. Neidium pseudogracilis H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 243. pl. 1, f. 3–4.
88. Neidium skvortsovi H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 243–244. pl. 1, f. 5–6.
89. Neidium tokyoense H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 244. pl. 1, f. 1–2.

Pinnulariaceae
90. Pinnularia acidobionta Tuji & Tosh.Watan., 2003, Diatom 19: 47–49. f. 1–12.
91. Pinnularia caudata var. maior Hirano, 1976, Study Rep. Baika Jr. Coll. 25: 84. pl. 7, f. 2–3.
92. Pinnularia osoresanensis (Negoro) Fukush. et al., 2002, Diatom 18: 8.
≡ Pinnularia acoricula var. osoresanensis Negoro, 1944, Sci. Rep. Tokyo Bunr. Daig., sec. B. 6: 317. f. 3c.
93. Pinnularia acrophaerica var. hyalina H.Kobayasi in Kobayasi & Ando 1977, Bull. Tokyo Gakugei Univ., ser. 4. 29: 244–245. pl. 4, f. 29–30.
94. Pinnularia bicepsoides H.Kobayasi, 1975, Bull. Tokyo Gakugei Univ., ser. 4. 27: 193. pl. 4, f. 47–50.
95. Pinnularia negoroi Fukush. et al., 2002, Diatom 18: 2.
≡ Pinnularia braunii var. undulata Negoro, 1944, Sci. Rep. Tokyo Bunr. Daig., sec. B. 6: 310. f. 2.
96. Pinnularia gibba var. dissimilis H.Kobayasi, 1975, Bull. Tokyo Gakugei Univ., ser. 4. 27: 194. pl. 5, f. 71–73.
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