

## Typification of *Nitzschia minuta* Bleisch and *N. palea* f. *major* Rabenhorst (*Bacillariaceae*, *Bacillariophyceae*)

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*Nitzschia palea* (Kützing) W.Smith (1856: 89), one of the most widespread species in our rivers and lakes worldwide (Trobajo & Cox 2006), is often misidentified. The species has been the subject of intensive morphological and molecular analyses in an attempt unambiguously to classify relevant specimens (Trobajo & Cox 2006, Trobajo & al. 2009). At least 28 varieties and formae have been described (Guiry & Guiry 2025), some of which are now recognised as independent taxa (e.g. *N. palea* var. *tenuirostris* Grunow = *N. saprobionta* Van de Vijver & de Zwart 2023) or considered synonyms of other *Nitzschia* species such as *N. palea* var. *romana* (Grunow) H.Peragallo, now included in the synonymy of *N. fonticola* (Grunow) Grunow. Krammer & Lange-Bertalot (1988, pl. 59) dismissed several of these infraspecific taxa together with several other *Nitzschia* species simply as synonyms of *N. palea* broadening that way the morphological variability of the nominate species. Trobajo & al. (2009) analysed several *N. palea* strains including some that could be identified as *N. palea* var. *debilis* (Kützing) Grunow (in Cleve & Grunow 1880: 96) but concluded that although a strict separation between the nominate and the var. *debilis* was no longer tenable solely based on morphological characters, several taxa could be identified within the analysed strains (Trobajo & al. 2009: 457). Despite this, Lange-Bertalot & al. (2017, pl. 113) retained several independent varieties (such as var. *debilis*) but lumped others with the nominative *N. palea*. Two of these lumped taxa include *Nitzschia minuta* Bleisch and *N. palea* var. *major* Rabenhorst, both distinctly longer and/or wider than the nominative *N. palea*. Although infrequent, valves identified as one of these two taxa are illustrated (e.g. Reichardt 2018, pls 382, 383). The type material of both has never been examined in detail, making it unclear whether they are conspecific or should be kept as separate taxa. However, on [www.diatom.org](http://www.diatom.org), isotype valves are shown based on original Bleisch material of *N. minuta* (Kociolek 2011).

*Nitzschia minuta* Bleisch was originally described in 1860 as exsiccata No. 950 in Rabenhorst's 'Algen Sachsens resp. Mittel-Europa'. The material was collected in September 1859 by Eduard Bleisch 'Am Galgenberge bei Strehlen in Schlesien' [now Strehlen, in Lower Silesia, Poland]. A short validating description was included on the label "Der *N. amphioxys* und *minutissima* ähnlich, aber viel schmaler, fast lanzettlich. Striche finde ich nicht bemerklich, auf *amphioxys* deutlich. Punkte an den Rändern 30 auf 0.001 Engl. Zoll (*N. minutissima* hat 70 in 0.001 engl. Zoll. (Similar to *N. amphioxys* and *minutissima*, but much narrower, almost lanceolate. I do not find any noticeable lines, but *amphioxys* has them. The margins have 30 points per 0.001 inch (=25 µm) (*N. minutissima* has 70 points per 0.001 inch.))" Grunow (1862: 578) reported the species but also suggested that it could be the same as *Synedra fusidium* Kützing (Kützing 1844: 64). *Synedra fusidium* was described from a sample near Nordhausen as "S(ynedra), sparsely linear on the primary side, slightly attenuate on both sides, secondarily lanceolate and more acute, length 38 µm. (*S. sparsa latere primario lineari, utrinque leviter attenuato, secundario lanceolato acutiusculo*, Lange 1/60''') and accompanied by 4 small drawings showing narrow, lanceolate cells lacking any further structure (Kützing 1844, pl. 30, fig. 33). Bleisch repeated his description of *N. minuta* in 1863 but never illustrated any specimens (Bleisch 1863: 78). The species was often considered in relation to *N. palea* (Kützing) W.Smith. Cleve & Grunow (1880: 96) concluded that the species could not be distinguished from *N. palea* and suggested the species was conspecific to *Synedra palea* var. *minor* Kützing. Subsequently, Grunow (in Van Heurck 1881, pl. 69: fig. 23) recombined

the species as *N. palea* var. *minuta* (Bleisch) Grunow, illustrating two valves and a frustule, the drawings based on Eulenstein's sample 24 but not of the original Bleisch material. Lange-Bertalot (1976: 273) questioned this combination stating that the use of Eulenstein's material as the reason for the confusion and reconsidered *N. minuta* as an independent taxon ("sollte Bleischs Taxon erhalten bleiben"). Krammer & Lange-Bertalot (1988: 85) once again included *N. minuta* in the *N. palea*-complex as 'minuta-Sippen' adding *Nitzschia (Synedra) fusidium* (Kützing) H.L. Smith as synonym. Reichardt (2018: 236, pl. 383: figs 56–66) separated the species again from *N. palea* as an independent taxon.

The second taxon considered in this contribution was separated by Rabenhorst (1864: 160) as *Nitzschia palea* f. *major* from the nominate *N. palea* based on its longer valves (43 µm) and the fact that the valves are "sometimes subradially aggregated (*nonnunquam subradiatim aggregata*)". Rabenhorst also referred his new forma to *Synedra fusidium* but did not mention *N. minuta*. He did not illustrate his forma. Later, Grunow (in Van Heurck 1881, pl. 49, fig. 22c) illustrated one valve identified as *N. palea* f. *major*, a drawing based on a Rabenhorst sample from Dresden. The latter sample (Rabenhorst 844, Dresden, im Ausflusse der Weiszeritz in die Elbe und auf Elbschlamm unterhalb der Marienbrücke, collected by C.A. Hantzsch) was originally labelled *Nitzschia parvula* and was included in the Grunow collection as Grunow sample 1221. Krammer & Lange-Bertalot (1988) added the f. *major* to the *Nitzschia palea*-complex as 'major-sippen', characterised by longer and wider valves. Two synonyms were added: *Nitzschia pilum* Hustedt (1942: 210, fig. 1) and *N. fruticosa* Hustedt (1957: 349, figs 81, 82) although the latter addition was considered questionable given the addition of '(?)' to the name.

It is unclear, however, what *Synedra fusidium* represents. Analysis of the type material (Kützing sample 209 from Nordhausen) proved to be extremely confusing (Van de Vijver, pers. obs.) and Kützing's drawings of *S. fusidium* are also not very informative. The species was described as present "Unter verschiedenen Diatomeen im süßen wasser bei Nordhausen!". The sample contains a lot of different *Nitzschia* species that could all match both the description and the drawings in Kützing (1844) but could easily also be identified as *N. palea*. Therefore, it is unclear which of the two taxa discussed in the current contribution could be conspecific with *S. fusidium* (that should have priority as name). Based on this, it is best for now to exclude *S. fusidium* from the current analysis.

Neither in the most recent version of the Freshwater Benthic Diatoms of Central Europe (Lange-Bertalot & al. 2017) nor in its additional volume (Werum & al. 2024), were *N. palea* f. *major* or *N. minuta* included, most likely as they were still considered to be synonyms of *N. palea*. Moreover, apart from a few LM illustrations in Krammer & Lange-Bertalot (1988, pl. 59: figs 11, 13–15), the type populations of these taxa are not well known. Therefore, the present contribution illustrates the morphology of the type material of both *N. minuta* and *N. palea* f. *major* using light and scanning electron microscopy, to increase our knowledge of the type of these two taxa. Further analysis of non-type populations, including molecular analysis, will be necessary to assess their taxonomic validity. Without detailed knowledge of the types, any discussion about these two taxa is baseless. An emended description for the type materials of both taxa is presented below, and both taxa are lectotypified.

***Nitzschia minuta*** Bleisch (Figs 1–18, 39–43).

Original description: Label for the exsiccata No. 950, Rabenhorst, Die Algen Sachsens resp. Mittel-Europa's. Decas 95-96, 1860.

**Lectotype (here designated):** BR-4918 (Meise Botanic Garden, Belgium), slide made from Rabenhorst Algen Sachsens resp. Mittel-Europa No. 950, "Am Galgenberge bei Strehlen in Schlesien in September 1859, Poland". The lectotype is represented by Fig. 4.

Registration (for the typification): <http://phycobank.org/106014>

Synonyms: *Nitzschia communis* var. *minuta* (Bleisch) Kirchner (187: 198). *Nitzschia palea* var. *minuta* Grunow (in Van Heurck, 1881: expl. pl. LXIX [69]: figs. 23)

Description: Valves broadly linear-lanceolate with parallel, straight to weakly convex margins tapering halfway valve centre and apices towards narrowly protracted, almost symmetrical, rostrate apices. Valve dimensions (n=50): length 24–35 µm, width 4.5–5.0 µm. Valve face flat. Raphe keel indistinct, very weakly pronounced, almost flat. Raphe positioned on the side of the keel, continuous from apex to apex. Central nodule absent. Terminal raphe fissures unilaterally curved. Striae equidistant, parallel, weakly curved and radiate near apices, 30–35 in 10 µm, distinctly discernible in LM. Virgae separating areolae broader than areola rows. Striae composed of small, rounded to irregularly shaped, weakly depressed areolae, 40–45 areolae in 10 µm. First row of areolae on raphe keel more apically flattened. Fibulae rather robust, irregularly spaced along raphe slit, middle fibulae not distinctly more spaced than the others, 13–14 in 10 µm. Internally, fibulae connected to 2, rarely 3 striae. Terminal raphe endings terminating onto distinct helictoglossae.

***Nitzschia palea* f. *major*** Rabenhorst (Figs 19–38)

Original description: Rabenhorst (1864: 160).

**Lectotype (here designated):** BR-4919 (Meise Botanic Garden, Belgium), slide prepared from Rabenhorst Algen Sachsens resp. Mittel-Europa No. 844, Weiszeritz, Dresden, leg. C.A. Hantzsch. The lectotype is illustrated by Fig. 28.

Registration (for the typification): <http://phycobank.org/106015>

Description: Valves broadly linear-lanceolate with parallel, straight to weakly convex margins tapering from about 2/3 between valve centre and apices towards narrowly protracted, asymmetrical rostrate apices. Apices more straight on the side opposite raphe keel. Valve dimensions (n=40): length 24–41 µm, width 4.0–4.5 µm. Valve face flat. Raphe keel indistinct, very weakly pronounced, almost flat. Raphe positioned on the side of the keel, continuous from apex to apex. Central nodule absent. Terminal raphe fissures unilaterally curved, either towards primary or secondary side. Striae equidistant, parallel, weakly curved and radiate near apices, 35–40 in 10 µm, not or only very weakly discernible in LM. Virgae separating areolae as broad as or slightly broader than areola rows. Striae composed of small, rounded to irregularly shaped, weakly depressed areolae, 40–50 areolae in 10 µm. First row of areolae on raphe keel not different than other areolae. Fibulae rather robust, irregularly spaced along raphe slit, middle fibulae not distinctly more spaced than the others, 12–17 in 10 µm. Internally fibulae connected to 1–3 striae.

Both taxa differ in small details: stria density, valve outline, valve width, areola shape on the raphe keel, although in some features, an overlap can be seen (e.g. fibula density). In LM, both can be easily separated based on their stria density. Valves identified as *N. minuta* are always slightly wider with striae that can relatively easily be counted in LM. *Nitzschia palea* var. *major* valves are somewhat narrower and the striae are very hard to see in LM. In Reichardt (2018) this difference is clearly seen. *Nitzschia minuta*, shown in his pl. 383, figs 56–66, has well-discernible striae whereas in *N. palea* f. *major* striae are visible but much harder to discern. Both taxa can also be separated in valve outline with *N. minuta* having more robust, less protracted valves and *N. palea* f. *major* having more elongated valves. Based on these, however subtle, differences, both taxa should be kept separate.

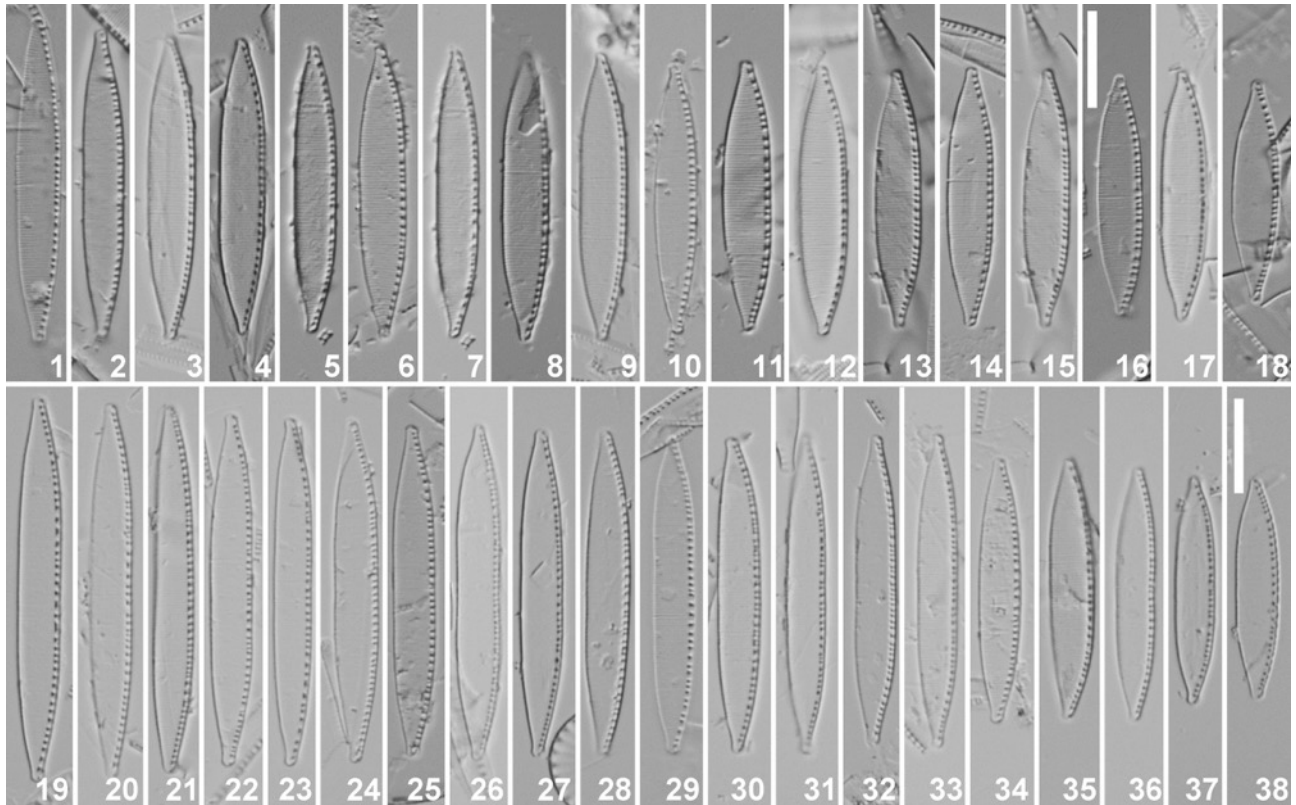
Wolf-Henning Kusber is thanked for his advice on the lectotypification of both names.

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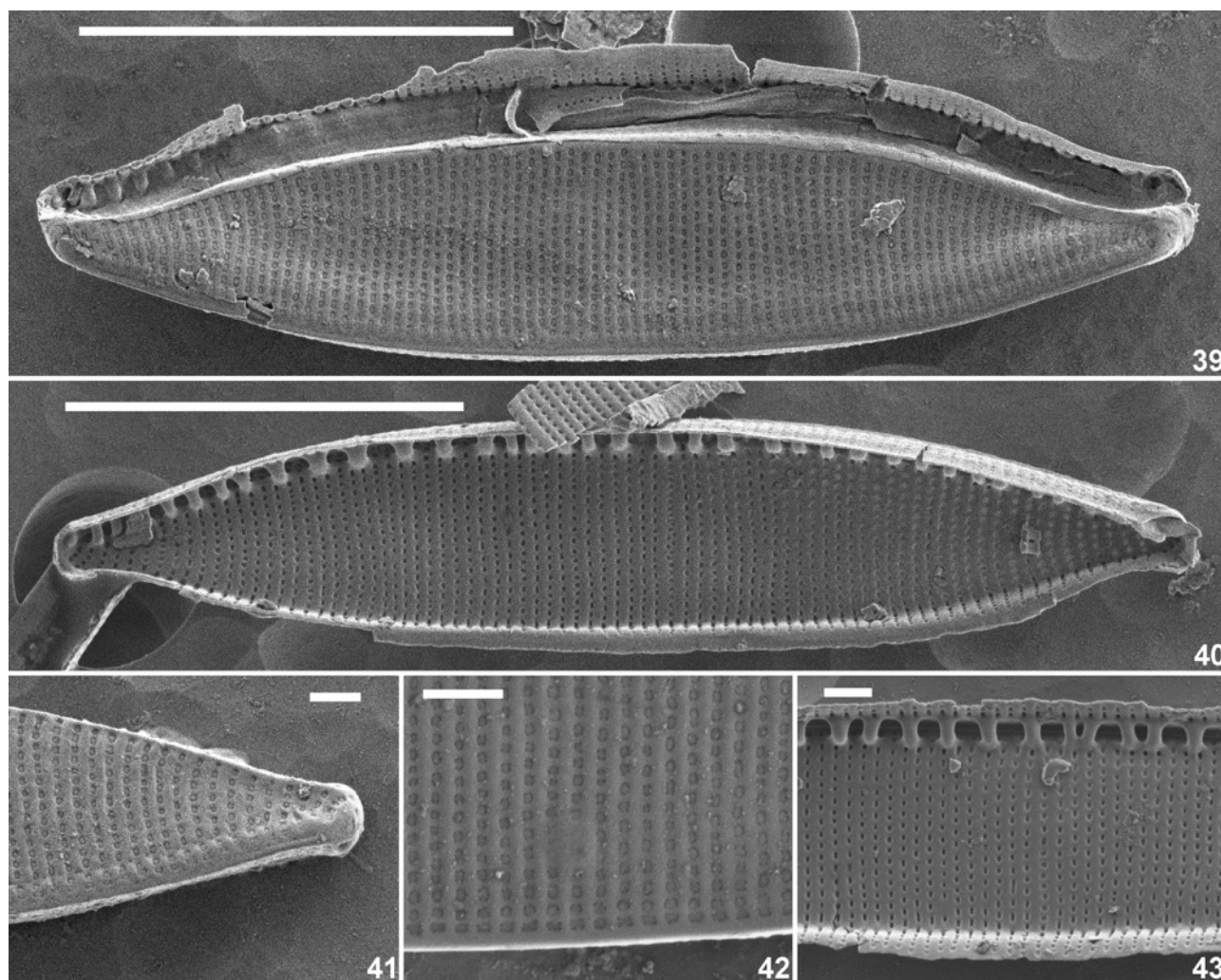
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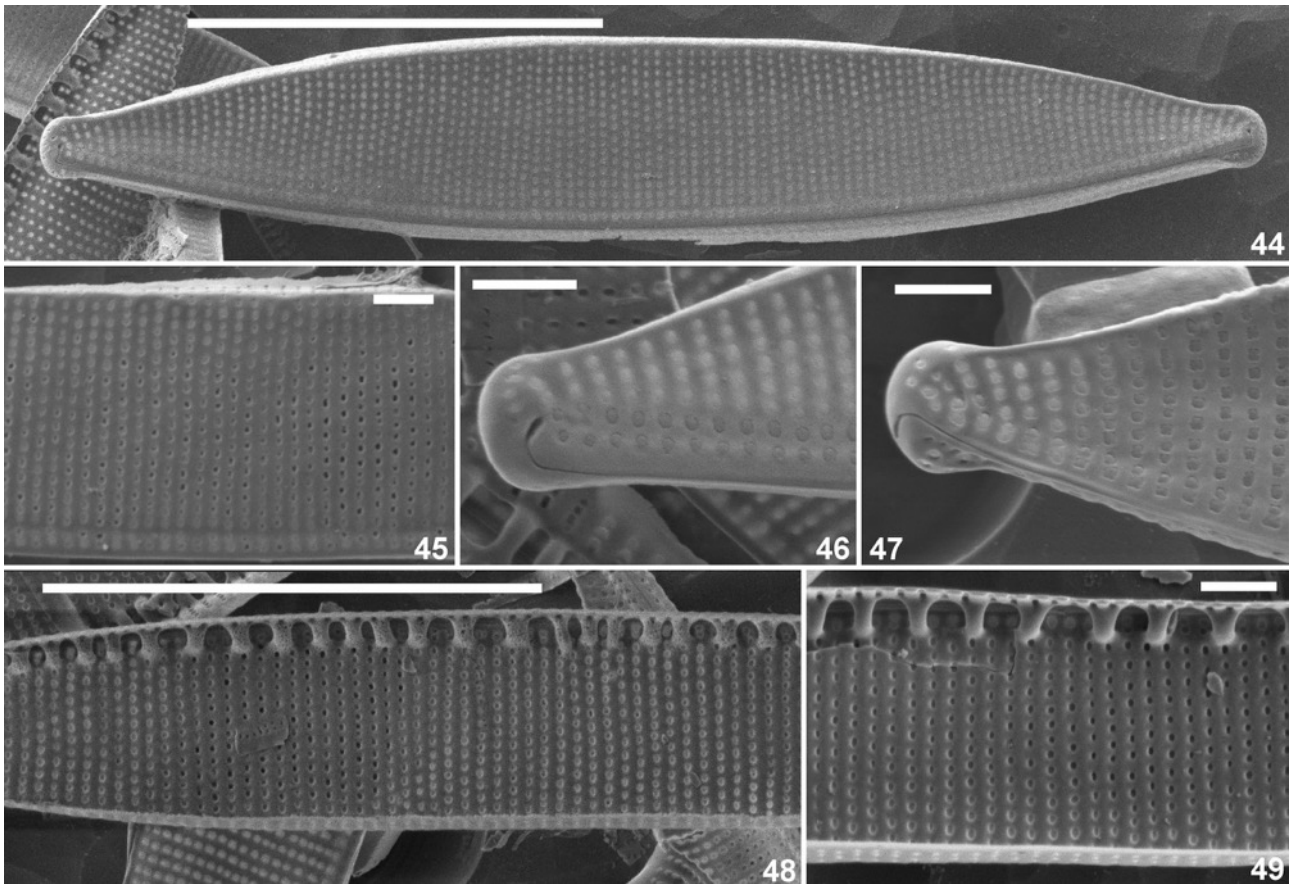
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**Figs 1–35. *Nitzschia minuta*** Bleisch in Rabenhorst (Figs 1–18) and *Nitzschia palea* f. *major* Rabenhorst (Figs 1–19). LM pictures taken from the lectotype slides [Rabenhorst Algen Sachsens resp. Mittel-Europa Nos 950 (*N. minuta*, BR-4918) and 844 (*N. palea* f. *major*, BR-4919)]. Scale bars = 10  $\mu$ m.



**Figs 39–43.** *Nitzschia minuta* Bleisch in Rabenhorst. SEM pictures taken from the lectotype sample (BR-4918, Rabenhorst Algen Sachsens resp. Mittel-Europa No. 950). **Fig. 39.** SEM external view of entire valve. **Fig. 40.** SEM internal view of entire valve. **Fig. 41.** SEM external detail of the valve apex. **Fig. 42.** SEM external detail of the stria pattern. Note the flattened areolae at the keel. **Fig. 43.** SEM internal view of the valve centre showing the fibulae. Scale bars = 10 µm except for Figs 41–43 where scale bar = 1 µm.



**Figs 39–43.** *Nitzschia palea* f. *major* Rabenhorst. SEM pictures taken from the lectotype sample (BR-4919, Rabenhorst Algen Sachsens resp. Mittel-Europa No. 844). **Fig. 44.** SEM external view of entire valve. **Fig. 45.** SEM external detail of the striation pattern. Note the lack of shape difference between all areolae, even at the keel. **Figs 46–47.** SEM external details of the valve apex with terminal raphe fissures curving into different directions. **Figs 48–49.** SEM internal views of the valve centre showing the fibulae. Scale bars = 10  $\mu\text{m}$  except for Figs 45–47, 49 where scale bar = 1  $\mu\text{m}$ .