Parthenogenesis

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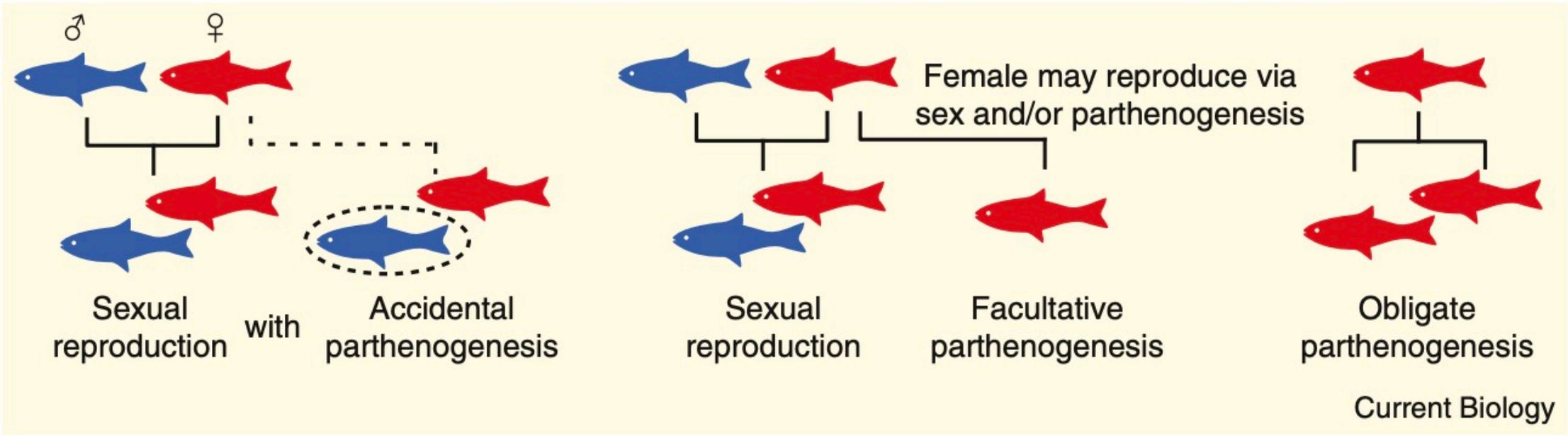


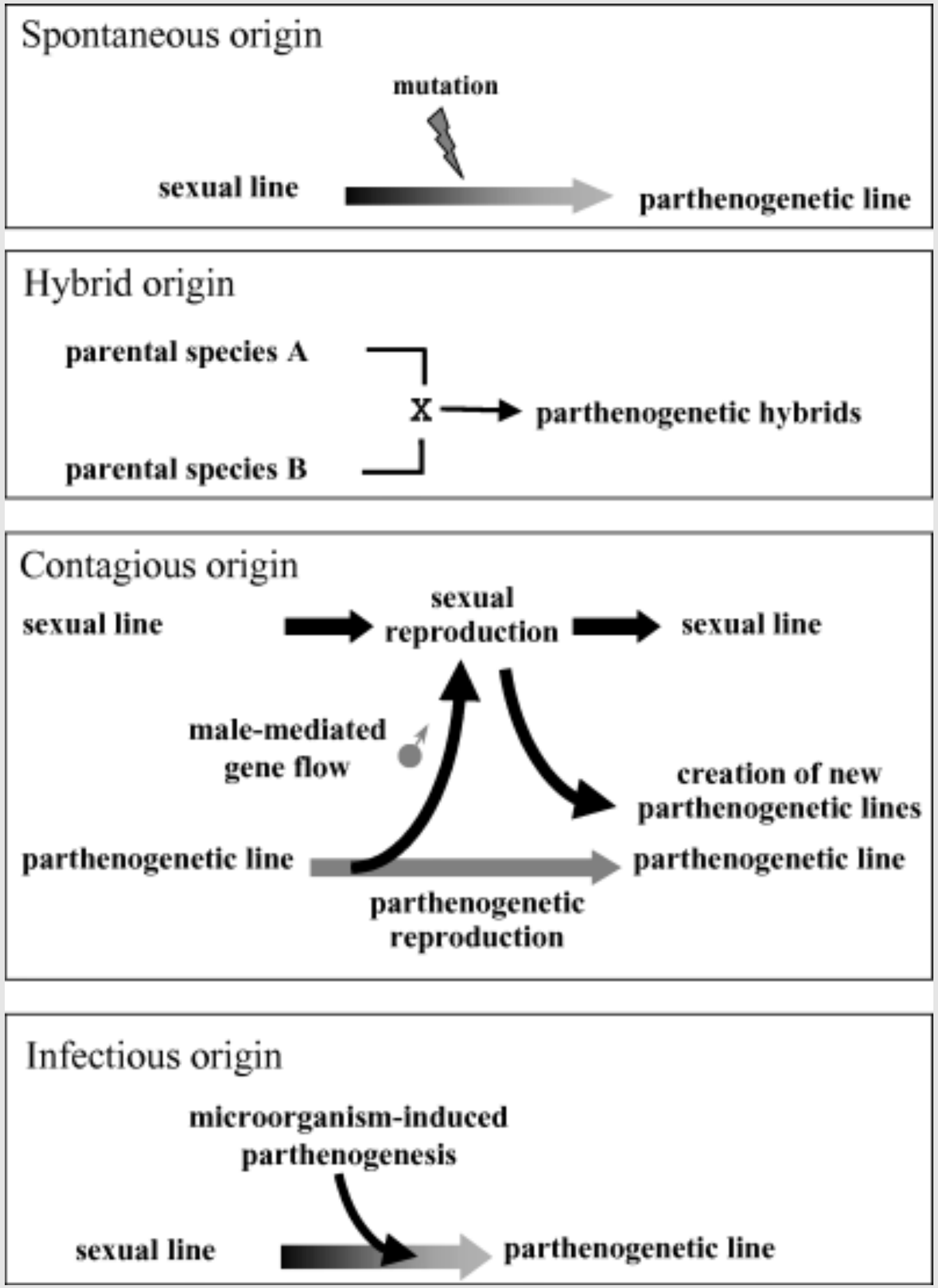
Figure 1. The efficiency of parthenogenesis varies widely.

Accidental parthenogenesis refers to the very rare hatching of unfertilized eggs in sexual populations, often due to reproductive errors, that can generate male offspring in species with female heterogamety. Given the very low hatching success, accidental parthenogenesis is often not adaptive. Under facultative parthenogenesis a female may reproduce via sex and/or parthenogenesis; hence this reproductive mode combines the advantages of sex and parthenogenesis. Under obligate parthenogenesis, females cannot reproduce sexually at all, even if mated to males of sexual lineages. Populations consisting solely of obligate parthenogens are characterized by the virtual absence of males. However, many species feature mixed reproduction, with some females reproducing sexually and others via obligate parthenogenesis. These species are characterized by sex ratios ranging from 50:50 to strongly female-biased.

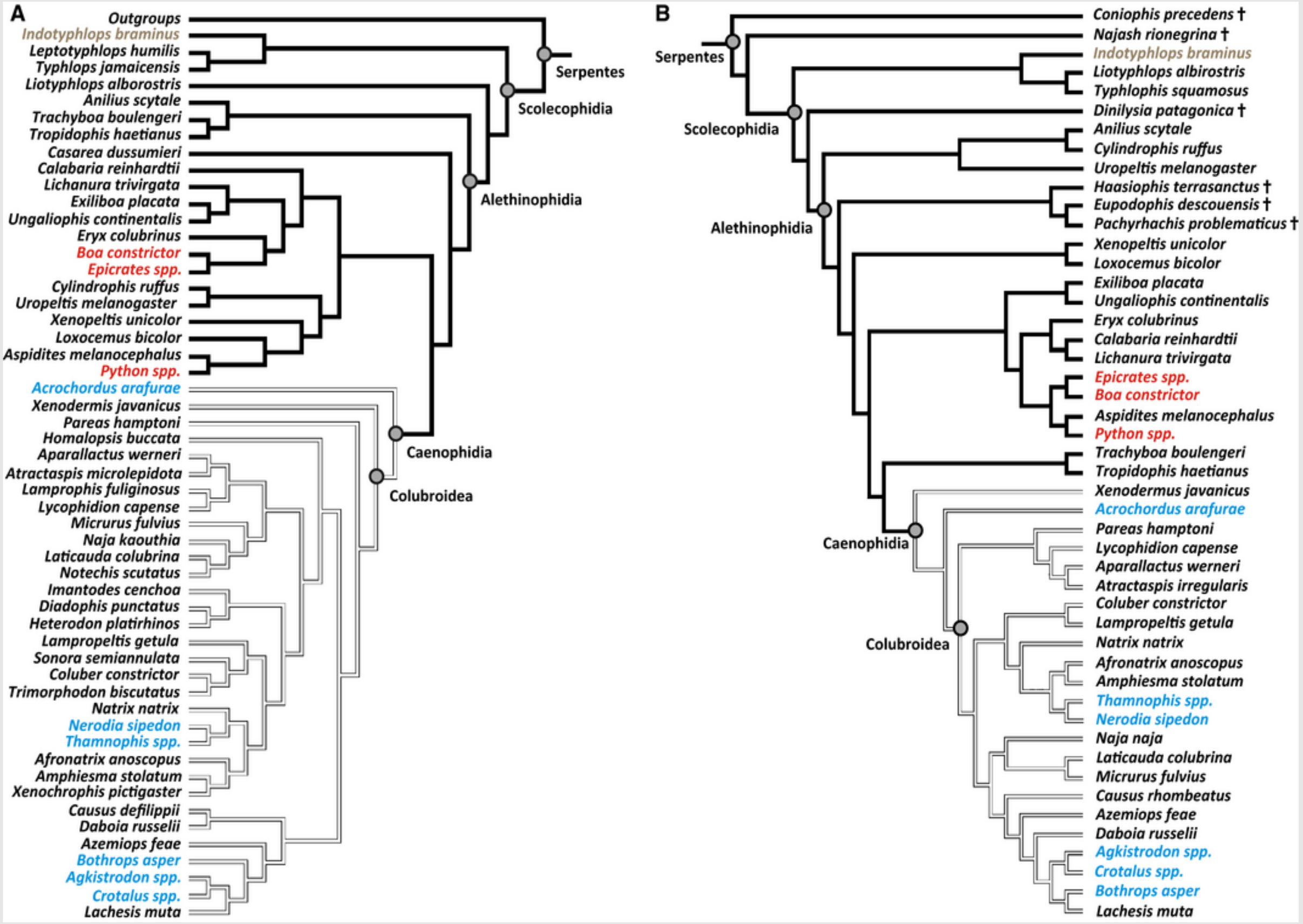
van der Kooi and Schwander 2015

- *Tychoparthenogenesis* (or facultative parthenogenesis) refers to the occasional, spontaneous development of eggs without fertilization in animals. Occasional or facultative parthenogenesis is quite common: for example, it is found in at least ten insect orders and occurs with obligate parthenogenesis in genera within at least six of them. The cytological mechanisms associated with tychoparthenogenesis are diverse and include both apo- and automixis (see below). It is likely that some obligately parthenogenetic species have evolved from tychoparthenogenetic ones.
- *Apomictic parthenogenesis* (or **apomixis**) involves the suppression of meiosis so that offspring are produced from unfertilized eggs by a mitosis-like cell division resulting in genetic identity to the mother, barring mutation. Apomixis is commonly found in invertebrates such as rotifers and all major groups of arthropods.
- *Automictic parthenogenesis* (or **automixis**), in contrast to apomixis, retains meiosis with restoration of diploidy by duplication or fusion of the gametes produced by the female parent. Automixis occurs in many parthenogenetic stick insects and some weevils. In general, it rapidly leads to complete homozygosity.
- *Gynogenesis* is a form of parthenogenesis in which sperm from a related bisexual species are required to stimulate egg development without contributing to the genetic composition of the offspring.
- *Hybridogenesis* is a hemiclonal mode of reproduction in that half of the genome is transmitted sexually while the other half is transmitted clonally. Sperm and egg nuclei fuse and paternal genes are expressed in the offspring, but only the maternal genome is transmitted to the next generation. For example, both gynogenesis and hybridogenesis are utilized by unisexual fish species in the genus *Poeciliopsis*.

Simon et al. 2003



Simon et al. 2003



Where possible, species documented as being parthenogenetic are indicated in brown (obligate), red (facultative, type A), and blue (facultative, type B). (Booth & Schuett 2016)

Between 2004 and 2013, 190 individuals ranging in stretched total length (STL) from 67.1 to 381 cm were sampled, tagged, and released … Sixteen microsatellite loci were used to genotype these individuals). These loci had from 4 to 40 alleles (mean = 20) and conformed to Hardy-Weinberg equilibrium … The program STORM was used to calculate the internal relatedness (IR) of each individual, a parameter that expresses the relatedness of the individual's parents. Outbred individuals will have an IR close to zero while individuals derived from close kin mating are expected to exhibit IR values from ~0.25 to 0.50 (i.e., indicating that the individual's parents were half or full-siblings, respectively). An IR value close to or equal to 1 indicates near or complete homozygosity across surveyed loci, which is consistent with all known cases of facultative parthenogenesis in vertebrates. (Fields et al. 2015)

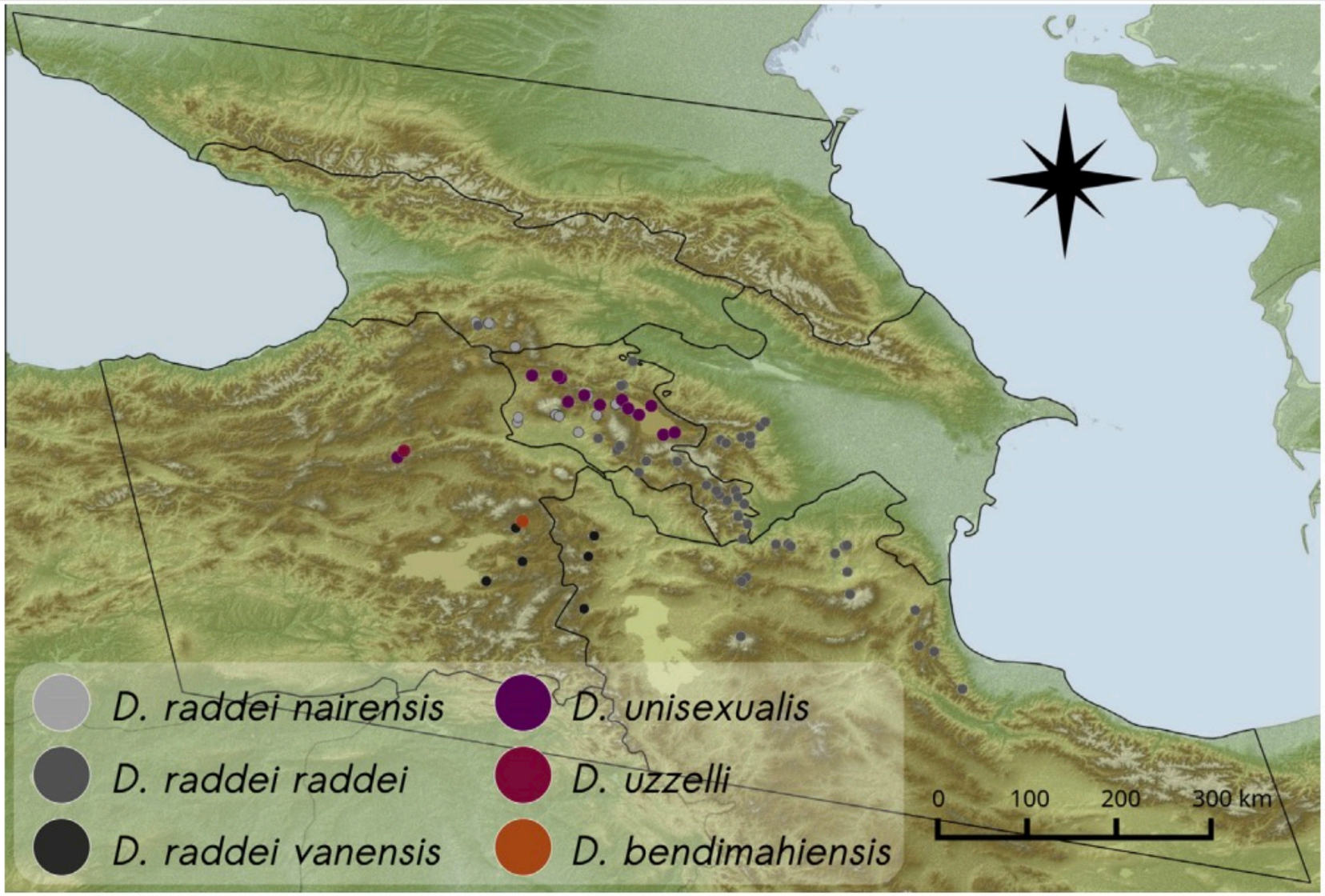


Fig. 1. Map with all individuals used in the study (for both Maxent model construction and genetic analyses) identified by species-specific colour codes. Ecotypes of sexual species *D. raddei* are in different tones of grey (light grey, "nairensis"; medium grey, "raddei"; dark grey, "vanensis"). Parthenogenetic species are represented in purple (*D. unisexualis*), dark pink (*D. uzzelli*) and orange (*D. bendimahiensis*). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

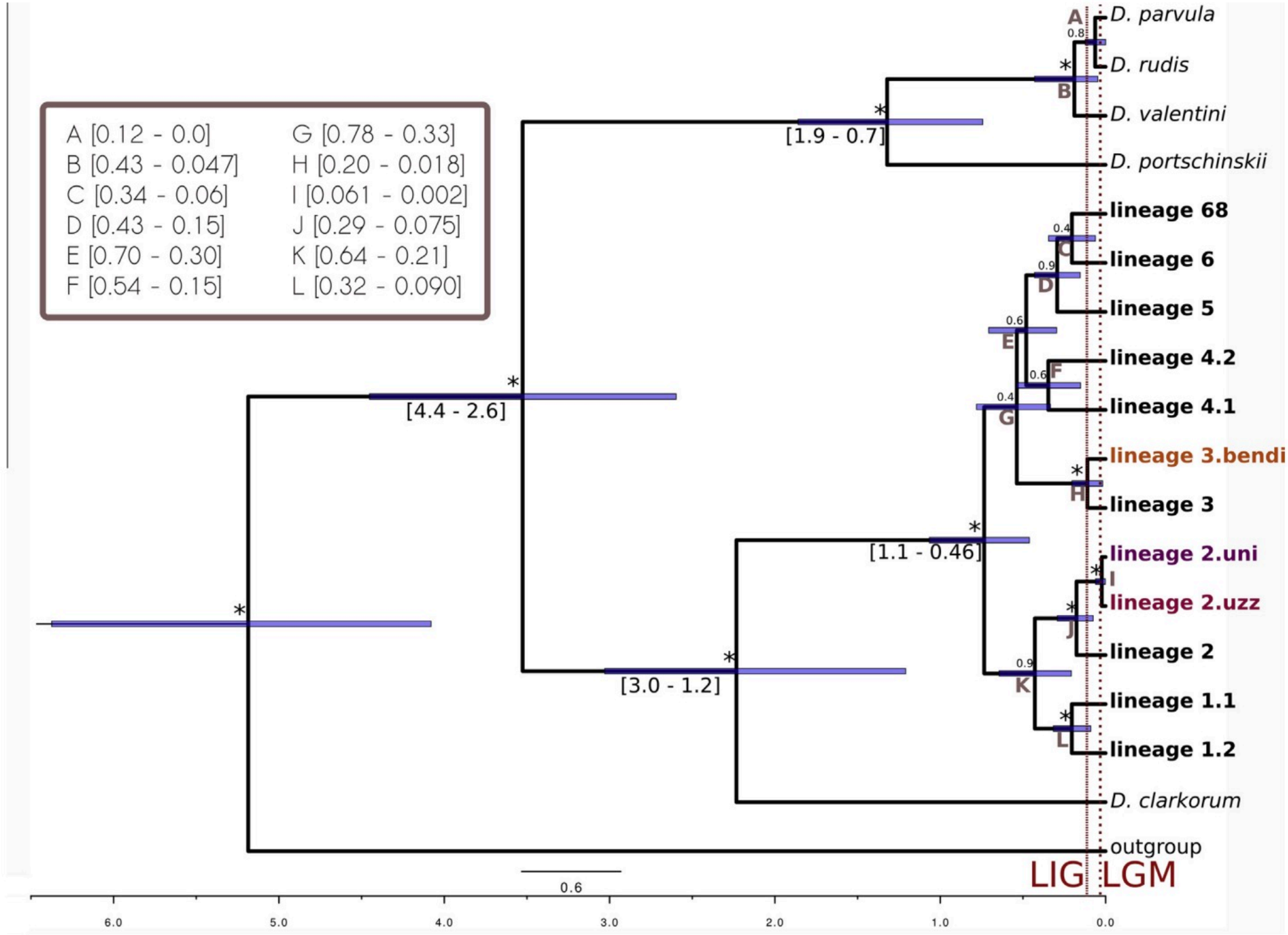


Fig. 3. Species-tree estimate (MCC) of *D. raddei* sensu lato and the parthenogenetic species *D. unisexualis* (lineage 2.uni), *D. uzzelli* (lineage 2.uzz) and *D. bendimahiensis* (lineage 3.bendi). Divergence time intervals in Myrs. Posterior probabilities are presented for each split, stars represents posterior probability of 1. Parthenogenetic species are shown in different colours, similar as in other figures (orange: *D. bendimahiensis*, purple: *D. unisexualis*, dark pink: *D. uzzelli*). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)