

Rebase 2021 Year in review

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Update of Rebase 2021

In the year 2021, Rebase increased the number of entries by 8,453, including 7,341 sequences published on Rebase Reports. The total number of entries reached 66,570 at the end of the year 2021. The majority (97.7%) of these entries are transposable elements (TEs), either consensus or representative sequences. The remaining are satellite repeats and microsatellites (599 entries), multicopy genes (196 entries), integrated viruses (200 entries), and uncharacterized repeats.

Rebase transitioned to a subscription-based model on April 12, 2019. The last version of Rebase before the transition was Rebase Update 24.03 which included 50,356 entries. Since then, we have (1) increased the number of repeats published in each issue of Rebase Reports, and (2) covered more diverse organisms each month (Table 1). The choice of organisms is based on (1) the economic and scientific importance, (2) the quality of the genome sequence, and (3) the phylogenetic distance from well-analyzed organisms. We have also continually updated, corrected, and refined existing repeats that contain sequence flaws or are ambiguously classified. We updated over 700 such entries in the year 2021.

At the end of the year 2021, Rebase contains repeat sequences from over 1,300 species. From each of the 149 species among them, >100 entries have been registered. The numbers of entries for each of three TE-rich species (yellow fever mosquito, Asian rice, and zebrafish) exceed 2,000 (Table 2). Sometimes, multiple genomes in the same genus, such as *Drosophila* and *Arabidopsis*, have been sequenced and analyzed. Such analysis helps characterize very low-copy TE families or single-copy TE families in model organisms and reveal the genome evolution over a longer time scale. Table 3 shows the total numbers of Rebase entries for each genus. In some cases, such as *Chondrus* and *Locusta*, only one species is analyzed, while in

other cases, such as *Drosophila* and *Anopheles*, more than 2 species have been examined (Tables 4 and 5). Table 6 shows the top 20 species whose entries increased in the year 2021. Even though the genomes of model organisms are very well analyzed, they still contain TE families to be discovered. The characteristics of several species we focused on in the year 2021 are described below.

Arabidopsis lyrata (lyrate rockcress)

The lyrate rockcress *Arabidopsis lyrata* is a close relative of *Arabidopsis thaliana*, the best-studied land plant species. They belong to the family Brassicaceae, which includes several economically important crops, such as cabbage, Chinese cabbage, rapeseed, and radish. In Repbase, there are 516 entries from radish (*Raphanus sativus*), 381 from Chinese cabbage (*Brassica rapa*), 99 from cabbage (*Brassica oleracea*), and 84 from *Schrenkiella parvula/Eutrema parvum*. Repbase now contains 956 and 1,567 repeat entries from *A. thaliana* and *A. lyrata*, respectively. In contrast to *A. thaliana*, which is predominantly self-pollinated, *A. lyrata* shows self-incompatibility and thus mainly outcrosses, which may explain the outnumbered TE families in *A. lyrata* compared to *A. thaliana*.

Medicago truncatula (barrel medic)

The barrel medic, *Medicago truncatula* is studied as a model organism for legume biology. Legume (Fabaceae) includes many important crops such as soybeans and peanuts. Most legumes have symbiotic nitrogen-fixing bacteria in structures called root nodules. Legumes can be consumed as food for humans (grain legumes), such as soybeans, peas and peanuts, as well as for animals (forage legumes), such as alfalfa (*Medicago sativa*) and clover. Now Repbase contains 872 entries from *M. truncatula*, 558 from *Glycine max* (soybean), 208 from *Arachis ipaensis* (a wild progenitor of peanuts), 119 from *Arachis hypogaea* (peanut), 76 from *Cicer arietinum* (chickpea), 54 from *Trifolium pratense* (red clover), 24 from *Senna tora* (sickle senna), 13 from *Pisum sativum* (pea), 9 from *Trifolium repens* (white clover), 9 from *Lotus corniculatus* (common bird's-foot trefoil), 8 from *Lotus japonicus* (miyakogusa), 4 from *Vicia faba* (fava bean), 2 from *Phaseolus vulgaris* (common bean), and 1 from *Cajanus cajan* (pigeon pea).

Aedes aegypti (yellow fever mosquito)

The yellow fever mosquito is a pest that can spread devastating diseases including yellow fever, dengue fever, and Zika fever. The genome of this pest insect is very TE family-rich; especially

LTR retrotransposons are very diverse. Reported 3,005 LTR retrotransposons from *A. aegypti* are now classified into 1,331 *Gypsy*, 366 *Copia*, and 1,308 *BEL* LTR retrotransposons. User should note that LTR retrotransposons deposited in Repbase are stored in two parts, the LTR and the internal portion.

Anopheles (malaria mosquitoes)

Malaria is one of the most severe public health problems worldwide. Malaria is caused by parasitic protists of the genus *Plasmodium*. Four kinds of malaria parasites infect humans: *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*. Malaria parasites are transmitted to humans by female mosquitoes of the genus *Anopheles*. In the year 2021, three mosquito genomes (*A. funestus*, *A. merus*, and *A. stephensi*) of the subgenus *Cellia* were analyzed and 252 repeats are added to Repbase. *A. funestus* is the major vector of malaria in sub-Saharan Africa. *A. stephensi* is the primary vector of malaria in urban India. *A. merus* is the closest relative of *A. gambiae*. Many TE families are shared in the two genomes with very high sequence identities.

Crassostrea gigas (Pacific oyster)

The Pacific oyster (*Crassostrea gigas*) is now the most widely farmed and the most commercially important oyster globally. It is native to Asia. It is also considered an invasive species where it has been introduced intentionally or accidentally. In the year 2021, the entries from *C. gigas* increased by 398, and the total number of entries is 1,470.

Drosophila (fruit flies)

The genus *Drosophila* contains over 1,450 species, among which ~1,100 species belong to the subgenus *Drosophila*. *D. melanogaster* belongs to the subgenus *Sophophora*. In the year 2021, 7 sequences from *Drosophila melanogaster* were added to Repbase, as well as 430 TE families from *D. takahashii*, and 145 from *D. elegans* (Table 4). In total, Repbase contains 3,303 repeat entries from the genus *Drosophila*.

Carassius auratus (goldfish)

The goldfish (*Carassius auratus*) is one of the most popular aquarium fish and belongs to the family Cyprinidae of the order Cypriniformes. Goldfish have been selectively bred for color, size, body shape, and fin configuration for 1,000 years. Goldfish and zebrafish *Danio rerio*

belong to the same order. Rebase currently contains 306 entries from goldfish, 107 from its relative, the common carp *Cyprinus carpio*, and 2,323 from zebrafish.

Lepidopteran pests in the family Noctuidae

The family Noctuidae commonly known as owlet moths, cutworms, or armyworms, is one of the largest families in Lepidoptera, and includes major pests that devastatingly damage crops. In the year 2021, 4 species belonging to Noctuidae were analyzed: *Spodoptera exigua* (beet armyworm), *Spodoptera frugiperda* (fall armyworm), *Trichoplusia ni* (cabbage looper), and *Helicoverpa armigera* (cotton bollworm), as well as two other lepidopteran insects *Manduca sexta* (tobacco hornworm, Sphingidae) and *Megathymus ursus* (bear giant skipper, Hesperiiidae) (Table 7).

TE classification

The number of Rebase entries in each TE category is shown in Table 8, including the increase in the number of entries in the last three years. In the year 2021, we updated our classification scheme based on recent findings. Two new subgroups (*Lokiretrovirus* and *Spumaretrovirus*) were introduced under Endogenous retroviruses (ERV). The clade *Lokiretrovirus* was reported by Wang and Han (2021). An enigmatic lineage of LTR retrotransposons designated *BHIKHARI*, reported from the zebrafish genome (Vogel and Gerster 1999), found its place in *Lokiretrovirus*. Several other ERVs such as *ERV5-1_PM* from the sea lamprey *Petromyzon marinus*, and *ERV-1_SSa* from the Atlantic salmon *Salmo salar*, also belong to *Lokiretrovirus* and thus were renamed. *Spumaretrovirus* has long been recognized as a distinct subfamily (*Spumaretrovirinae*) inside of the family *Retroviridae* in the ICTV taxonomy (<https://talk.ictvonline.org/taxonomy/>). The first example of endogenous spumaretrovirus was *ERV1-2_DR* from zebrafish (Bao and Jurka 2008), and several endogenous spumaretroviruses have been reported since then (Katzourakis et al. 2009; Han and Worobey 2012; Aiewsakun and Katzourakis 2017).

Recent discoveries of new *Penelope*-like retrotransposons (*Penelope*-like elements, PLEs) revealed the diversity of this group of retrotransposons. Following the classification by Craig et al. (2021), several new subgroups (*Penelope/Poseidon*, *Neptune*, *Nematis*, *Athena*, *Coprina*, *Hydra*, and *Naiad/Chlamys*) were integrated into the classification system of Rebase. Except

for *Athena* and *Coprina*, they encode GIY-YIG endonucleases for their target-primed reverse transcription (TPRT). *Naiad/Chlamys* encode the endonuclease upstream of their RT domain, while *Penelope/Poseidon*, *Neptune*, *Nematis*, and *Hydra* encode the endonuclease downstream of their RT domain. All but 17 *Penelope*-like retrotransposons present before the introduction of this scheme were successfully classified into one of these subgroups. Ten of the remained 17 families represent early branched lineages, which may or may not belong to these subgroups. The other families are non-autonomous or short fragments, which are hard to be classified with certainty. Table 9 shows the new classification of all *Penelope*-like elements published on Rebase by Oct. 12, 2021.

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Table 1. Organisms published in each issue of Repbase Reports.

RR issue	Published entries	Vertebrates	Invertebrates	Plants	Fungi	Others
21(1)	522	<i>Sphenodon</i> (tuatara), <i>Geotrypetes</i> (caecilian), <i>Denticeps</i> (herring)	<i>Aedes</i> (mosquito), <i>Sitophilus</i> (weevil), <i>Trichoplusia</i> (moth)	<i>Arabidopsis</i> , <i>Raphanus</i> (radish)		
21(2)	566	<i>Sphenodon</i> (tuatara), <i>Geotrypetes</i> (caecilian), <i>Lepisosteus</i> (gar), <i>Thunnus</i> (tuna), <i>Hippoglossus</i> (halibut)	<i>Anopheles</i> (mosquito), <i>Manduca</i> (moth)	<i>Medicago</i> (barrel medic)		
21(3)	554	<i>Carassius</i> (goldfish), <i>Lacerta</i> (lizard), <i>Cyclopterus</i> (lumpfish), <i>Anableps</i> (four eyes)	<i>Crassostrea</i> (oyster), <i>Orius</i> (bug), <i>Bradysia</i> (gnat), <i>Actinia</i> (coral)	<i>Zea</i> (maize)		
21(4)	590	<i>Carassius</i> (goldfish), <i>Syngnathus</i> (pipefish), <i>Echeneis</i> (sharksucker), <i>Poeciliopsis</i>	<i>Aedes</i> (mosquito), <i>Osmia</i> (bee), <i>Spodoptera</i> (moth)	<i>Arabidopsis</i>	<i>Podosphaera</i>	<i>Tisochrysis</i>
21(5)	572	<i>Carassius</i> (goldfish), <i>Neostethus</i> , <i>Acanthopagrus</i> (seabream)	<i>Biomphalaria</i> (planorb), <i>Acropora</i> (coral)	<i>Medicago</i> (barrel medic)	<i>Podosphaera</i> , <i>Colletotrichum</i> , <i>Saitozyma</i>	<i>Tisochrysis</i>
21(6)	628	<i>Larimichthys</i> (crocker), <i>Silurus</i> (catfish)	<i>Anopheles</i> (mosquito), <i>Megathymus</i> (butterfly), <i>Drosophila</i>	<i>Raphanus</i> (radish), <i>Arabidopsis</i> , <i>Ilex</i> (yerba mate)	<i>Podosphaera</i> , <i>Cercospora</i> , <i>Elsinoe</i>	<i>Phytophythium</i>
21(7)	559	<i>Kryptolebias</i> , <i>Megalops</i> (tarpon)	<i>Tegillarca</i> (clam), <i>Caligus</i> (sea louse)	<i>Medicago</i> (barrel medic)	<i>Arthrobotrys</i> , <i>Clohesyomyces</i> , <i>Dicyma</i> , <i>Didymella</i> , <i>Esteya</i> , <i>Fusarium</i>	
21(8)	645	<i>Microcaecilia</i> (caecilian), <i>Erpetoichthys</i> (reedfish)	<i>Aedes</i> (mosquito), <i>Drosophila</i> , <i>Cyclina</i> (clam), <i>Poecilobdella</i> (leech)	<i>Zea</i> (maize)	<i>Phellinus</i> , <i>Hypomyces</i>	
21(9)	644	<i>Acipenser</i> (sterlet)	<i>Sinella</i> (springtail), <i>Drosophila</i> , <i>Clonorchis</i> (fluke)	<i>Arabidopsis</i> , <i>Panicum</i> (millet)	<i>Tuber</i> , <i>Penicillium</i> , <i>Ilyonectria</i> , <i>Metschnikowia</i> , <i>Batrachochytrium</i>	
21(10)	662	<i>Amblyraja</i> (skate), <i>Perca</i> (perch)	<i>Helicoverpa</i> (moth), <i>Drosophila</i> , <i>Crassostrea</i> (oyster)	<i>Medicago</i> (barrel medic), <i>Senna</i>	<i>Madurella</i> , <i>Linderina</i> , <i>Blumeriella</i> , <i>Porodaedalea</i> , <i>Aspergillus</i> , <i>Cryptococcus</i>	
21(11)	638	<i>Dendropsophus</i> (frog), <i>Xenopus</i> (frog)	<i>Drosophila</i> , <i>Mengenilla</i> , <i>Dendronephthya</i> (coral), <i>Necator</i> (nematode)	<i>Zea</i> (maize), <i>Coffea</i> (coffee), <i>Ilex</i> (yerba mate), <i>Camellia</i> (tea)	<i>Zymoseptoria</i> , <i>Davidsoniella</i> , <i>Neosartorya</i>	
21(12)	761	<i>Xiphophorus</i> (swordtail), <i>Colossoma</i> (tambaqui), <i>Dermostichelys</i> (turtle)	<i>Drosophila</i> , <i>Spodoptera</i> (moth), <i>Anopheles</i> (mosquito), <i>Crassostrea</i> (oyster), <i>Caenorhabditis</i> (nematode)	<i>Arabidopsis</i> , <i>Cannabis</i> (hemp), <i>Capsicum</i> (chili pepper), <i>Ilex</i> (yerba mate),	<i>Morchella</i> , <i>Floccularia</i> , <i>Bipolaris</i>	<i>Trypanosoma</i> , <i>Naegleria</i>

Species whose repeats are published first in Repbase Reports are colored in red.

Table 2. Top 20 species based on the number of Rebase entries.

Species	Total	2021 Increase
<i>Aedes aegypti</i> (yellow fever mosquito)	3648	329
<i>Oryza sativa</i> (Asian rice)	3075	0
<i>Danio rerio</i> (zebrafish)	2323	0
<i>Arabidopsis lyrata</i> (lyrate rockcress)	1567	798
<i>Zea mays</i> (maize)	1481	467
<i>Crassostrea gigas</i> (Pacific oyster)	1470	398
<i>Chondrus crispus</i> (Irish moss)	1183	0
<i>Locusta migratoria</i> (migratory locust)	1127	0
<i>Sorghum bicolor</i> (sorghum)	971	0
<i>Arabidopsis thaliana</i> (thale cress)	956	0
<i>Medicago truncatula</i> (barrel medic)	872	644
<i>Chrysemys picta bellii</i> (painted turtle)	843	0
<i>Nematostella vectensis</i> (starlet sea anemone)	757	0
<i>Hydra vulgaris</i> (hydra)	745	0
<i>Culex quinquefasciatus</i> (southern house mosquito)	660	0
<i>Lepeophtheirus salmonis</i> (salmon louse)	654	0
<i>Xenopus tropicalis</i> (western clawed frog)	628	73
<i>Homo sapiens</i> (human)	583	0
<i>Drosophila takahashii</i> (fruit fly)	574	430
<i>Glycine max</i> (soybean)	558	0
<i>Salmo salar</i> (Atlantic salmon)	535	0
<i>Malus domestica</i> (apple)	526	0

Table 3. Top 20 genera based on the number of Rebase entries.

Genus (Species with >10 entries)	Total	2021 Increase
<i>Aedes</i> (<i>A. aegypti</i>)	3649	329
<i>Drosophila</i> ¹	3303	502
<i>Oryza</i> (<i>O. sativa</i>)	3084	0
<i>Arabidopsis</i> (<i>A. thaliana</i> , <i>A. lyrata</i>)	2523	798
<i>Danio</i> (<i>D. rerio</i>)	2323	0
<i>Crassostrea</i> (<i>C. gigas</i> , <i>C. virginica</i>)	1642	398
<i>Zea</i> (<i>Z. mays</i>)	1483	467
<i>Chondrus</i> (<i>C. crispus</i>)	1183	0
<i>Locusta</i> (<i>L. migratoria</i>)	1127	0
<i>Sorghum</i> (<i>S. bicolor</i>)	971	0
<i>Xenopus</i> (<i>X. tropicalis</i> , <i>X. laevis</i>)	920	74
<i>Puccinia</i> (<i>P. striiformis</i> , <i>P. graminis</i> , <i>P. hordei</i> , <i>P. triticina</i> , <i>P. coronata</i> , <i>P. horiana</i>)	884	0
<i>Medicago</i> (<i>M. truncatula</i>)	878	644
<i>Chrysemys</i> (<i>C. picta</i>)	843	0
<i>Phytophthora</i> (<i>P. infestans</i> , <i>P. sojae</i> , <i>P. ramorum</i> , <i>P.</i> <i>parasitica</i>)	783	0
<i>Nematostella</i> (<i>N. vectensis</i>)	758	0
<i>Hydra</i> (<i>H. vulgaris</i>)	745	0
<i>Culex</i> (<i>C. quinquefasciatus</i>)	669	0
<i>Lepeophtheirus</i> (<i>L. salmonis</i>)	654	0
<i>Anopheles</i> ²	635	252

1 Species are shown in Table 4.

2 Species are shown in Table 5.

Table 4. Repbase entries from the genus *Drosophila*.

Subgenus - Group (subgroup)	Species	Abbr.	Repbase entries	2021 Increase
<i>Sophophora</i> - <i>melanogaster</i> (<i>melanogaster</i> subgroup)	<i>D. melanogaster</i>	DM	296	7
	<i>D. simulans</i>	DSim	43	0
	<i>D. sechellia</i>	DSe	33	9
	<i>D. yakuba</i>	DY	139	3
	<i>D. erecta</i>	DEre	18	9
(<i>suzukii</i> subgroup)	<i>D. biarmipes</i>	DBi	80	0
(<i>ananassae</i> subgroup)	<i>D. ananassae</i>	DAn	240	0
	<i>D. bipectinata</i>	DBp	158	0
(<i>elegans</i> subgroup)	<i>D. elegans</i>	DEl	314	145
(<i>takahashii</i> subgroup)	<i>D. takahashii</i>	DTa	574	430
(<i>rhopaloa</i> subgroup)	<i>D. rhopaloa</i>	DRh	116	0
(<i>montium</i> subgroup)	<i>D. kikkawai</i>	DKi	97	0
	<i>D. serrata</i>	DSer	71	0
<i>Sophophora</i> - <i>ficuspbila</i>	<i>D. ficuspbila</i>	DF	129	0
<i>Sophophora</i> - <i>eugracilis</i>	<i>D. eugracilis</i>	DEu	78	0
<i>Sophophora</i> - <i>obscura</i>	<i>D. azteca</i>	DAzt	102	0
	<i>D. pseudoobscura</i>	DPse	80	0
	<i>D. persimilis</i>	DPer	106	0
<i>Sophophora</i> - <i>willistoni</i>	<i>D. willistoni</i>	DWil	240	-1
<i>Siphlodora</i> - <i>repleta</i>	<i>D. mojavensis</i>	DMoj	154	0
	<i>D. hydei</i>	DHyd	39	0
<i>Siphlodora</i> - <i>virilis</i>	<i>D. virilis</i>	DVi	88	0
<i>Idiomyia</i>	<i>D. grimshawi</i>	DGri	41	0

¹ Only species with >10 entries are shown.

² Subgroups are shown only in the *melanogaster* group.

Table 5. Repbase entries from the genus *Anopheles*.

Species	Abbr.	Repbase entries	2021 Increase
<i>A. gambiae</i> str. PEST	AG	379	0
<i>A. funestus</i>	AnFu	140	140
<i>A. merus</i>	AnMe	68	68
<i>A. stephensi</i>	AnSt	44	44

¹ Only species with >10 entries are shown.

Table 6. Top 20 species whose entries increased in 2021.

Species	2021 Increase	Total
<i>Arabidopsis lyrata</i> (lyrate rockcress)	798	1567
<i>Medicago truncatula</i> (barrel medic)	644	872
<i>Zea mays</i> (maize)	467	1481
<i>Drosophila takahashii</i> (fruit fly)	430	574
<i>Crassostrea gigas</i> (Pacific oyster)	398	1470
<i>Aedes aegypti</i> (yellow fever mosquito)	329	3648
<i>Carassius auratus</i> (goldfish)	304	306
<i>Raphanus sativus</i> (radish)	294	516
<i>Dendropsophus ebaraccatus</i> (hourglass tree frog)	182	182
<i>Sinella curviseta</i> (springtail)	174	174
<i>Sphenodon punctatus</i> (tuatara)	164	238
<i>Drosophila elegans</i> (fruit fly)	145	314
<i>Cyclina sinensis</i> (Chinese venus)	144	144
<i>Anopheles funestus</i> (mosquito)	140	140
<i>Tisochrysis lutea</i> (haptophyte)	139	147
<i>Xiphophorus hellerii</i> (green swordtail)	131	131
<i>Podosphaera xanthii</i>	127	127
<i>Manduca sexta</i> (tobacco hornworm)	122	123
<i>Amblyraja radiata</i> (thorny skate)	104	286
<i>Caligus rogercresseyi</i> (sea louse)	103	103

Table 7. Repbase entries from lepidopteran insects.

Species	Abbr.	Rebase entries	2021 Increase
<i>Manduca sexta</i> (tobacco hornworm)	MSe	123	122
<i>Spodoptera exigua</i> (beet armyworm)	SpEx	218	80
<i>Spodoptera frugiperda</i> (fall armyworm)	SpFr	55	54
<i>Trichoplusia ni</i> (cabbage looper)	TrNi	95	93
<i>Helicoverpa armigera</i> (cotton bollworm)	HeAr	92	90
<i>Bombyx mori</i> (domestic silkworm)	BM	106	0
<i>Megathymus ursus</i> (bear giant skipper)	MeUr	49	43
<i>Heliconius melpomene melpomene</i>	HMM	268	0
<i>Papilio xuthus</i> (Asian swallowtail)	PXu	42	0
<i>Papilio polytes</i> (common Mormon)	PPo	179	0

¹ Only species with >10 entries are shown.

Table 8. TE classification and the numbers of entries in Repbase.

A. LTR retrotransposon

Superfamily	Total	2021 increase	2020 increase	2019 increase
<i>Gypsy</i>	17599	4139	1843	432
<i>Copia</i>	8865	908	569	314
<i>BEL</i>	3047	432	432	311
<i>DIRS</i>	832	187	186	41
Endogenous Retrovirus (ERV)				
<i>ERV1</i>	2307	45	115	160
<i>ERV2</i>	1563	0	102	182
<i>ERV3</i>	817	0	18	129
<i>ERV4</i>	193	0	0	6
<i>Lentivirus</i>	4	0	0	0
<i>Lokiretrovirus</i>	51	-	-	-
<i>Spumaretrovirus</i>	6	-	-	-
Unclassified ERV	318	-10	0	3
Unclassified LTR retrotransposon	737	9	44	-37
Total	36339	5767	3310	1541

B. Penelope-like retrotransposon

Superfamily	Total	2021 increase	2020 increase	2019 increase
<i>Penelope/Poseidon</i>	289	-	-	-
<i>Neptune</i>	220	-	-	-
<i>Nematis</i>	5	-	-	-
<i>Athena</i>	42	-	-	-
<i>Coprina</i>	12	-	-	-
<i>Hydra</i>	22	-	-	-
<i>Naiad/Chlamys</i>	2	-	-	-
Unclassified <i>Penelope</i>	17	-	-	-
Total	609	77	11	27

C. Non-LTR retrotransposon

Superfamily (clade)	Total	2021 increase	2020 increase	2019 increase
SINE				
<i>SINE1/7SL</i>	100	0	1	4
<i>SINE2/tRNA</i>	811	133	60	74
<i>SINE3/5S</i>	26	-6	0	1
<i>SINEU/snRNA</i>	17	0	0	0
Unclassified SINE	73	-39	1	0
<i>CRE</i>	53	5	0	7
<i>R4</i>	53	0	1	6
<i>Hero</i>	28	0	4	1
<i>NeSL</i>	118	0	0	0
<i>R2</i>	161	1	0	1
<i>RandI/Dualen</i>	13	0	0	0
<i>Proto1</i>	10	4	0	0
<i>L1</i>	2166	195	184	56
<i>Tx1</i>	305	1	21	5
<i>RTETP</i>	1	0	0	0
<i>Proto2</i>	52	0	5	0
<i>RTEX</i>	153	5	4	4
<i>RTE</i>	567	14	12	14
<i>Outcast</i>	31	8	0	0
<i>Ingi</i>	26	4	0	5
<i>Vingi</i>	153	0	10	0
<i>I</i>	208	4	1	0
<i>Nimb</i>	117	0	2	3
<i>Tad1</i>	487	177	19	108
<i>Loa</i>	88	1	6	5
<i>R1</i>	279	13	9	10
<i>Jockey</i>	298	19	18	5
<i>Rex1</i>	133	7	26	5
<i>CR1</i>	917	44	17	5
<i>Kiri</i>	105	13	1	0
<i>L2</i>	299	2	8	3
<i>L2A</i>	5	0	0	0
<i>L2B</i>	29	0	0	0
<i>Crack</i>	143	1	2	0
<i>Daphne</i>	239	1	2	6
<i>Ambal</i>	8	0	0	0
Unclassified non-LTR retrotransposon	208	23	5	0
Total	8480	630	419	333

D. DNA transposon

Superfamily	Total	2021 increase	2020 increase	2019 increase
<i>EnSpm/CACTA</i>	1108	195	156	10
<i>Transib</i>	182	39	8	13
<i>hAT</i>	4715	643	432	529
<i>MuDR</i>	2043	313	182	166
<i>P</i>	246	32	15	9
<i>Kolobok</i>	374	40	6	34
<i>Dada</i>	51	0	15	0
<i>Mariner/Tc1</i>	3156	136	171	229
<i>Zator</i>	89	6	22	7
<i>piggyBac</i>	431	10	21	23
<i>Merlin</i>	92	2	1	14
<i>Harbinger</i>	1780	221	279	115
<i>ISL2EU</i>	164	22	29	3
<i>Ginger1</i>	39	0	0	0
<i>Ginger2/TDD</i>	44	5	6	12
<i>IS3EU</i>	45	0	10	8
<i>Sola</i>				
<i>Sola1</i>	109	2	5	2
<i>Sola2</i>	103	5	6	0
<i>Sola3</i>	44	2	13	1
<i>Academ</i>	363	34	239	0
<i>Novosib</i>	9	0	0	0
<i>Zisupton</i>	42	1	19	3
<i>Helitron</i>	1440	218	201	41
<i>Polinton</i>	154	12	10	13
<i>Crypton</i>				
<i>CryptonF</i>	24	0	1	0
<i>CryptonA</i>	18	0	0	1
<i>CryptonI</i>	10	0	0	1
<i>CryptonS</i>	59	0	0	0
<i>CryptonV</i>	53	0	0	3
Unclassified <i>Crypton</i>	89	0	2	0
Unclassified DNA transposon	2344	35	-53	-53
Total	19420	1973	1796	1183

Table 9. Updated classification of *Penelope*-like elements.

Family name	New name	Subgroup
BRIDGE1_FR		Neptune
BRIDGE1_TN		Penelope/Poseidon
BRIDGE2_FR		Penelope/Poseidon
Coprina-1_SLL		Coprina
Coprina-2_SLL		Coprina
Coprina-3_SLL		Coprina
Coprina_Cc1		Coprina
Coprina_Pc1		Coprina
Coprina_Pc2		Coprina
I1_As	<i>Athena-I1_As</i>	Athena
I2_As	<i>Athena-I2_As</i>	Athena
I_Av	<i>Athena-I_Av</i>	Athena
JN_As	<i>Athena-JN_As</i>	Athena
JN_Av	<i>Athena-JN_Av</i>	Athena
JVY_As	<i>Athena-JVY_As</i>	Athena
JW_Av	<i>Athena-JW_Av</i>	Athena
JY_As	<i>Athena-JY_As</i>	Athena
K_As	<i>Athena-K_As</i>	Athena
K_Av	<i>Athena-K_Av</i>	Athena
L1_As	<i>Athena-L1_As</i>	Athena
L1_Av	<i>Athena-L1_Av</i>	Athena
L2_Av	<i>Athena-L2_Av</i>	Athena
L3_Av	<i>Athena-L3_Av</i>	Athena
M1_As	<i>Athena-M1_As</i>	Athena
M2_As	<i>Athena-M2_As</i>	Athena
M3_As	<i>Athena-M3_As</i>	Athena
M_Av	<i>Athena-M_Av</i>	Athena
NO_As	<i>Athena-NO_As</i>	Athena
N_As	<i>Athena-N_As</i>	Athena
Nematis_C4		Nematis
Nematis_Cr		Nematis
Nematis_Pp		Nematis
Neptune1_Ac		Neptune
Neptune1_Ap		Neptune
Neptune1_Nv		Neptune
Neptune1_Ren		Neptune
Neptune2_Ap		Neptune
Neptune2_Ren		Neptune
Neptune3_Ren		Neptune
Neptune_Hyd		Neptune
Neptune_Sp		Neptune
O_As	<i>Athena-O_As</i>	Athena
O_Av	<i>Athena-O_Av</i>	Athena
PENEL1_NVi		Penelope/Poseidon
PENELA_Smed		Penelope/Poseidon
PENELOPE		Penelope/Poseidon
PENELOPE_SM		Penelope/Poseidon
PERERE-10		Penelope/Poseidon
PNL2_SM		unclassified
PNL_SM		unclassified
P_As	<i>Athena-P_As</i>	Athena
P_Av	<i>Athena-P_Av</i>	Athena
Penelope-100_LMi		Penelope/Poseidon
Penelope-101_LMi		Penelope/Poseidon
Penelope-102_LMi		Penelope/Poseidon
Penelope-103_LMi		Penelope/Poseidon
Penelope-104_LMi		Penelope/Poseidon
Penelope-105_LMi		Penelope/Poseidon
Penelope-106_LMi		Penelope/Poseidon
Penelope-107_LMi		Penelope/Poseidon
Penelope-108_LMi		Penelope/Poseidon
Penelope-109_LMi		Penelope/Poseidon
Penelope-10_ACar	<i>Neptune-10_ACar</i>	Neptune
Penelope-10_CoFl		Penelope/Poseidon
Penelope-10_FoCa		Penelope/Poseidon
Penelope-10_HM	<i>Neptune-10_HM</i>	Neptune
Penelope-10_LMi		Penelope/Poseidon
Penelope-10_LVa		Penelope/Poseidon
Penelope-10_NV		Hydra

Penelope-10_PH		Penelope/Poseidon
Penelope-10_XL	Neptune-10_XL	Neptune
Penelope-10_XT	Neptune-10_XT	Neptune
Penelope-110_LMi		Penelope/Poseidon
Penelope-111_LMi		Penelope/Poseidon
Penelope-112_LMi		Penelope/Poseidon
Penelope-113_LMi		Penelope/Poseidon
Penelope-114_LMi		Penelope/Poseidon
Penelope-115_LMi		Penelope/Poseidon
Penelope-116_LMi		Penelope/Poseidon
Penelope-117_LMi		Penelope/Poseidon
Penelope-118_LMi		Penelope/Poseidon
Penelope-119_LMi		Penelope/Poseidon
Penelope-11_ACar	Neptune-11_ACar	Neptune
Penelope-11_CoFl		Penelope/Poseidon
Penelope-11_FoCa		Penelope/Poseidon
Penelope-11_HM	Neptune-11_HM	Neptune
Penelope-11_LMi		Penelope/Poseidon
Penelope-11_LVa		Penelope/Poseidon
Penelope-11_NV		unclassified
Penelope-11_PH		Penelope/Poseidon
Penelope-11_XL	Neptune-11_XL	Neptune
Penelope-11_XT	Neptune-11_XT	Neptune
Penelope-120N1_LMi		Penelope/Poseidon
Penelope-120_LMi		Penelope/Poseidon
Penelope-121_LMi		Penelope/Poseidon
Penelope-12B_LMi		Penelope/Poseidon
Penelope-12_HM	Neptune-12_HM	Neptune
Penelope-12_LMi		Penelope/Poseidon
Penelope-12_LVa		Penelope/Poseidon
Penelope-12_PH		Penelope/Poseidon
Penelope-12_XL	Neptune-12_XL	Neptune
Penelope-12_XT	Neptune-12_XT	Neptune
Penelope-13_HM		Hydra
Penelope-13_LMi		Penelope/Poseidon
Penelope-13_LVa		Penelope/Poseidon
Penelope-13_XL	Neptune-13_XL	Neptune
Penelope-13_XT	Neptune-13_XT	Neptune
Penelope-14_HM		Hydra
Penelope-14_LMi		Penelope/Poseidon
Penelope-14_XL	Neptune-14_XL	Neptune
Penelope-15N1_LMi		Penelope/Poseidon
Penelope-15N2_LMi		Penelope/Poseidon
Penelope-15_HM		Hydra
Penelope-15_LMi		Penelope/Poseidon
Penelope-15_LVa		Penelope/Poseidon
Penelope-15_XL	Neptune-15_XL	Neptune
Penelope-16_HM		Hydra
Penelope-16_LMi		Penelope/Poseidon
Penelope-16_LVa		Penelope/Poseidon
Penelope-16_XL	Neptune-16_XL	Neptune
Penelope-17_HM		Hydra
Penelope-17_LMi		Penelope/Poseidon
Penelope-17_LVa	Neptune-17_LVa	Neptune
Penelope-17_XL	Neptune-17_XL	Neptune
Penelope-18_HMa		Hydra
Penelope-18_LMi		Penelope/Poseidon
Penelope-18_LVa	Neptune-18_LVa	Neptune
Penelope-19_LMi		Penelope/Poseidon
Penelope-1A_NV		Hydra
Penelope-1B_CM	Neptune-1B_CM	Neptune
Penelope-1B_CPB	Neptune-1B_CPB	Neptune
Penelope-1B_XL	Neptune-1B_XL	Neptune
Penelope-1C_CPB	Neptune-1C_CPB	Neptune
Penelope-1N1_OD		unclassified
Penelope-1N1_PSi	Neptune-1N1_PSi	Neptune
Penelope-1N2_CPB	Neptune-1N2_CPB	Neptune
Penelope-1_AAe		Penelope/Poseidon
Penelope-1_AB	Coprina-1_AB	Coprina
Penelope-1_ACar	Neptune-1_ACar	Neptune
Penelope-1_ADi	Neptune-1_ADi	Neptune

Penelope-1_AEc		Penelope/Poseidon
Penelope-1_AFC		Penelope/Poseidon
Penelope-1_AMi	Neptune-1_AMi	Neptune
Penelope-1_BF		Penelope/Poseidon
Penelope-1_BTa		Penelope/Poseidon
Penelope-1_CGi	Neptune-1_CGi	Neptune
Penelope-1_CM	Neptune-1_CM	Neptune
Penelope-1_CMy	Neptune-1_CMy	Neptune
Penelope-1_CPB	Neptune-1_CPB	Neptune
Penelope-1_CQ		Penelope/Poseidon
Penelope-1_CTe	Neptune-1_CTe	Neptune
Penelope-1_CoFl		Penelope/Poseidon
Penelope-1_Crp	Neptune-1_Crp	Neptune
Penelope-1_DEI		Penelope/Poseidon
Penelope-1_DF		Penelope/Poseidon
Penelope-1_DK		Penelope/Poseidon
Penelope-1_DR	Neptune-1_DR	Neptune
Penelope-1_DRh		Penelope/Poseidon
Penelope-1_EuTe		Naiad/Chlamys
Penelope-1_FoCa	Neptune-1_FoCa	Neptune
Penelope-1_GA	Neptune-1_GA	Neptune
Penelope-1_Gav	Neptune-1_Gav	Neptune
Penelope-1_HM		Hydra
Penelope-1_HMM		Penelope/Poseidon
Penelope-1_HRo		Penelope/Poseidon
Penelope-1_LCh	Neptune-1_LCh	Neptune
Penelope-1_LG	Neptune-1_LG	Neptune
Penelope-1_LHu		Penelope/Poseidon
Penelope-1_LMi		Penelope/Poseidon
Penelope-1_LSal	Neptune-1_LSal	Neptune
Penelope-1_LVa		Penelope/Poseidon
Penelope-1_MLe	Nematis-1_MLe	Nematis
Penelope-1_NGe	Neptune-1_NGe	Neptune
Penelope-1_NV		Hydra
Penelope-1_NVi		Penelope/Poseidon
Penelope-1_OD		unclassified
Penelope-1_OL		Penelope/Poseidon
Penelope-1_PBa		Penelope/Poseidon
Penelope-1_PH		Penelope/Poseidon
Penelope-1_PSi	Neptune-1_PSi	Neptune
Penelope-1_SIn		Penelope/Poseidon
Penelope-1_SK		Hydra
Penelope-1_SM		unclassified
Penelope-1_SP		Penelope/Poseidon
Penelope-1_SSa	Neptune-1_SSa	Neptune
Penelope-1_TCas		Penelope/Poseidon
Penelope-1_XL	Neptune-1_XL	Neptune
Penelope-20_LMi		Penelope/Poseidon
Penelope-21_LMi		Penelope/Poseidon
Penelope-22_LMi		Penelope/Poseidon
Penelope-23_LMi		Penelope/Poseidon
Penelope-24_LMi		Penelope/Poseidon
Penelope-26_LMi		Penelope/Poseidon
Penelope-27_LMi		Penelope/Poseidon
Penelope-28_LMi		Penelope/Poseidon
Penelope-29_LMi		Penelope/Poseidon
Penelope-2B_Crp	Neptune-2B_Crp	Neptune
Penelope-2N1_NGe	Neptune-2N1_NGe	Neptune
Penelope-2_AAe		Penelope/Poseidon
Penelope-2_AB	Coprina-2_AB	Coprina
Penelope-2_ACar	Neptune-2_ACar	Neptune
Penelope-2_ADi	Neptune-2_ADi	Neptune
Penelope-2_AEc		Penelope/Poseidon
Penelope-2_BF		Penelope/Poseidon
Penelope-2_BTa		Penelope/Poseidon
Penelope-2_CGi		Naiad/Chlamys
Penelope-2_CPB	Neptune-2_CPB	Neptune
Penelope-2_CQ		Penelope/Poseidon
Penelope-2_CoFl		Penelope/Poseidon
Penelope-2_Crp	Neptune-2_Crp	Neptune
Penelope-2_DEI		Penelope/Poseidon

<i>Penelope-2_DR</i>	<i>Neptune-2_DR</i>	Neptune
<i>Penelope-2_FoCa</i>		Penelope/Poseidon
<i>Penelope-2_GA</i>	<i>Neptune-2_GA</i>	Neptune
<i>Penelope-2_HM</i>		Hydra
<i>Penelope-2_HMM</i>		Penelope/Poseidon
<i>Penelope-2_HRo</i>		Penelope/Poseidon
<i>Penelope-2_LG</i>		Penelope/Poseidon
<i>Penelope-2_LHu</i>		Penelope/Poseidon
<i>Penelope-2_LMi</i>		Penelope/Poseidon
<i>Penelope-2_LVa</i>		Penelope/Poseidon
<i>Penelope-2_Lch</i>		Penelope/Poseidon
<i>Penelope-2_MLe</i>		Penelope/Poseidon
<i>Penelope-2_NGe</i>	<i>Neptune-2_NGe</i>	Neptune
<i>Penelope-2_NV</i>		Hydra
<i>Penelope-2_OD</i>		unclassified
<i>Penelope-2_PBa</i>		Penelope/Poseidon
<i>Penelope-2_PH</i>		Penelope/Poseidon
<i>Penelope-2_PSi</i>	<i>Neptune-2_PSi</i>	Neptune
<i>Penelope-2_SIn</i>		Penelope/Poseidon
<i>Penelope-2_SK</i>		Hydra
<i>Penelope-2_SSa</i>	<i>Neptune-2_SSa</i>	Neptune
<i>Penelope-2_XL</i>	<i>Neptune-2_XL</i>	Neptune
<i>Penelope-30_LMi</i>		Penelope/Poseidon
<i>Penelope-31_LMi</i>		Penelope/Poseidon
<i>Penelope-32_LMi</i>		Penelope/Poseidon
<i>Penelope-33_LMi</i>		Penelope/Poseidon
<i>Penelope-34_LMi</i>		Penelope/Poseidon
<i>Penelope-35_LMi</i>		Penelope/Poseidon
<i>Penelope-36_LMi</i>		Penelope/Poseidon
<i>Penelope-37B_LMi</i>		Penelope/Poseidon
<i>Penelope-37_LMi</i>		Penelope/Poseidon
<i>Penelope-38_LMi</i>		Penelope/Poseidon
<i>Penelope-39_LMi</i>		Penelope/Poseidon
<i>Penelope-3B_DR</i>	<i>Neptune-3B_DR</i>	Neptune
<i>Penelope-3B_PH</i>		Penelope/Poseidon
<i>Penelope-3B_PSi</i>	<i>Neptune-3B_PSi</i>	Neptune
<i>Penelope-3N1_LMi</i>		Penelope/Poseidon
<i>Penelope-3_AAe</i>		Penelope/Poseidon
<i>Penelope-3_AB</i>	<i>Coprina-3_AB</i>	Coprina
<i>Penelope-3_ACar</i>	<i>Neptune-3_ACar</i>	Neptune
<i>Penelope-3_ADi</i>		Hydra
<i>Penelope-3_BF</i>		Penelope/Poseidon
<i>Penelope-3_BTa</i>		Penelope/Poseidon
<i>Penelope-3_CGi</i>	<i>Neptune-3_CGi</i>	Neptune
<i>Penelope-3_CQ</i>		Penelope/Poseidon
<i>Penelope-3_CoFl</i>		Penelope/Poseidon
<i>Penelope-3_Crp</i>	<i>Neptune-3_Crp</i>	Neptune
<i>Penelope-3_DR</i>	<i>Neptune-3_DR</i>	Neptune
<i>Penelope-3_FoCa</i>		Penelope/Poseidon
<i>Penelope-3_HM</i>		Hydra
<i>Penelope-3_HRo</i>		Penelope/Poseidon
<i>Penelope-3_LCh</i>	<i>Neptune-3_LCh</i>	Neptune
<i>Penelope-3_LG</i>	<i>Neptune-3_LG</i>	Neptune
<i>Penelope-3_LMi</i>		Penelope/Poseidon
<i>Penelope-3_LVa</i>		Penelope/Poseidon
<i>Penelope-3_MLe</i>	<i>Neptune-3_MLe</i>	Neptune
<i>Penelope-3_NV</i>		Hydra
<i>Penelope-3_OD</i>		unclassified
<i>Penelope-3_PH</i>		Penelope/Poseidon
<i>Penelope-3_PSi</i>	<i>Neptune-3_PSi</i>	Neptune
<i>Penelope-3_SIn</i>		Penelope/Poseidon
<i>Penelope-3_SSa</i>	<i>Neptune-3_SSa</i>	Neptune
<i>Penelope-3_XL</i>	<i>Neptune-3_XL</i>	Neptune
<i>Penelope-40_LMi</i>		Penelope/Poseidon
<i>Penelope-41_LMi</i>		Penelope/Poseidon
<i>Penelope-42_LMi</i>		Penelope/Poseidon
<i>Penelope-43_LMi</i>	<i>Neptune-43_LMi</i>	Neptune
<i>Penelope-44B_LMi</i>	<i>Neptune-44B_LMi</i>	Neptune
<i>Penelope-44_LMi</i>	<i>Neptune-44_LMi</i>	Neptune
<i>Penelope-45_LMi</i>		Penelope/Poseidon
<i>Penelope-46_LMi</i>		Penelope/Poseidon

<i>Penelope-47_LMi</i>	<i>Neptune-47_LMi</i>	Neptune
<i>Penelope-48_LMi</i>		Penelope/Poseidon
<i>Penelope-49_LMi</i>		Penelope/Poseidon
<i>Penelope-4N1_LVa</i>		Penelope/Poseidon
<i>Penelope-4_AAe</i>		Penelope/Poseidon
<i>Penelope-4_ACar</i>	<i>Neptune-4_ACar</i>	Neptune
<i>Penelope-4_ADi</i>		Penelope/Poseidon
<i>Penelope-4_BTa</i>		Penelope/Poseidon
<i>Penelope-4_CQ</i>		Penelope/Poseidon
<i>Penelope-4_CoFl</i>		Penelope/Poseidon
<i>Penelope-4_Crp</i>	<i>Neptune-4_Crp</i>	Neptune
<i>Penelope-4_DR</i>	<i>Neptune-4_DR</i>	Neptune
<i>Penelope-4_FoCa</i>	<i>Neptune-4_FoCa</i>	Neptune
<i>Penelope-4_HM</i>		Hydra
<i>Penelope-4_HRo</i>		Penelope/Poseidon
<i>Penelope-4_LG</i>	<i>Neptune-4_LG</i>	Neptune
<i>Penelope-4_LMi</i>		Penelope/Poseidon
<i>Penelope-4_LVa</i>		Penelope/Poseidon
<i>Penelope-4_NV</i>	<i>Neptune-4_NV</i>	Neptune
<i>Penelope-4_OD</i>		unclassified
<i>Penelope-4_PH</i>		Penelope/Poseidon
<i>Penelope-4_SIn</i>		Penelope/Poseidon
<i>Penelope-4_SSa</i>	<i>Neptune-4_SSa</i>	Neptune
<i>Penelope-4_XL</i>	<i>Neptune-4_XL</i>	Neptune
<i>Penelope-50_LMi</i>		Penelope/Poseidon
<i>Penelope-51_LMi</i>		Penelope/Poseidon
<i>Penelope-52B_LMi</i>	<i>Neptune-52B_LMi</i>	Neptune
<i>Penelope-52_LMi</i>	<i>Neptune-52_LMi</i>	Neptune
<i>Penelope-53_LMi</i>		Penelope/Poseidon
<i>Penelope-54_LMi</i>		Penelope/Poseidon
<i>Penelope-55_LMi</i>		Penelope/Poseidon
<i>Penelope-56_LMi</i>		Penelope/Poseidon
<i>Penelope-57_LMi</i>		Penelope/Poseidon
<i>Penelope-58_LMi</i>	<i>Neptune-58_LMi</i>	Neptune
<i>Penelope-59_LMi</i>		Penelope/Poseidon
<i>Penelope-5N1_BTa</i>		Penelope/Poseidon
<i>Penelope-5_AAe</i>		Penelope/Poseidon
<i>Penelope-5_ACar</i>	<i>Neptune-5_ACar</i>	Neptune
<i>Penelope-5_BTa</i>		Penelope/Poseidon
<i>Penelope-5_CoFl</i>		Penelope/Poseidon
<i>Penelope-5_DR</i>	<i>Neptune-5_DR</i>	Neptune
<i>Penelope-5_FoCa</i>		Penelope/Poseidon
<i>Penelope-5_HM</i>		Hydra
<i>Penelope-5_HRo</i>		Penelope/Poseidon
<i>Penelope-5_LMi</i>		Penelope/Poseidon
<i>Penelope-5_LVa</i>		Penelope/Poseidon
<i>Penelope-5_NV</i>	<i>merged with Neptune1_Nv</i>	Neptune
<i>Penelope-5_OD</i>		unclassified
<i>Penelope-5_PH</i>		Penelope/Poseidon
<i>Penelope-5_SIn</i>		Penelope/Poseidon
<i>Penelope-5_SSa</i>	<i>Neptune-5_SSa</i>	Neptune
<i>Penelope-5_XL</i>	<i>Neptune-5_XL</i>	Neptune
<i>Penelope-5_XT</i>		Penelope/Poseidon
<i>Penelope-60_LMi</i>		Penelope/Poseidon
<i>Penelope-62_LMi</i>		Penelope/Poseidon
<i>Penelope-63_LMi</i>		Penelope/Poseidon
<i>Penelope-64_LMi</i>		Penelope/Poseidon
<i>Penelope-65_LMi</i>		Penelope/Poseidon
<i>Penelope-66_LMi</i>		Penelope/Poseidon
<i>Penelope-67_LMi</i>		Penelope/Poseidon
<i>Penelope-68_LMi</i>		Penelope/Poseidon
<i>Penelope-69B_LMi</i>		Penelope/Poseidon
<i>Penelope-69_LMi</i>		Penelope/Poseidon
<i>Penelope-6N1_NV</i>	<i>Neptune-6N1_NV</i>	Neptune
<i>Penelope-6_AAe</i>		Penelope/Poseidon
<i>Penelope-6_ACar</i>	<i>Neptune-6_ACar</i>	Neptune
<i>Penelope-6_BTa</i>		Penelope/Poseidon
<i>Penelope-6_CoFl</i>		Penelope/Poseidon
<i>Penelope-6_FoCa</i>		Penelope/Poseidon
<i>Penelope-6_HM</i>		Hydra
<i>Penelope-6_HRo</i>		Penelope/Poseidon

<i>Penelope-6_LMi</i>		Penelope/Poseidon
<i>Penelope-6_LVa</i>		Penelope/Poseidon
<i>Penelope-6_NV</i>	<i>Neptune-6_NV</i>	Neptune
<i>Penelope-6_OD</i>		unclassified
<i>Penelope-6_PH</i>		Penelope/Poseidon
<i>Penelope-6_SIn</i>		Penelope/Poseidon
<i>Penelope-6_SSa</i>	<i>Neptune-6_SSa</i>	Neptune
<i>Penelope-6_XL</i>	<i>Neptune-6_XL</i>	Neptune
<i>Penelope-6_XT</i>		Penelope/Poseidon
<i>Penelope-70_LMi</i>		Penelope/Poseidon
<i>Penelope-71_LMi</i>		Penelope/Poseidon
<i>Penelope-72N1_LMi</i>		Penelope/Poseidon
<i>Penelope-72_LMi</i>		Penelope/Poseidon
<i>Penelope-73N1_LMi</i>		Penelope/Poseidon
<i>Penelope-73_LMi</i>		Penelope/Poseidon
<i>Penelope-74_LMi</i>		Penelope/Poseidon
<i>Penelope-75_LMi</i>		Penelope/Poseidon
<i>Penelope-76_LMi</i>		Penelope/Poseidon
<i>Penelope-77_LMi</i>		Penelope/Poseidon
<i>Penelope-78_LMi</i>		Penelope/Poseidon
<i>Penelope-79_LMi</i>		Penelope/Poseidon
<i>Penelope-7_ACar</i>	<i>Neptune-7_ACar</i>	Neptune
<i>Penelope-7_BTa</i>		Penelope/Poseidon
<i>Penelope-7_CoFl</i>		Penelope/Poseidon
<i>Penelope-7_FoCa</i>		Penelope/Poseidon
<i>Penelope-7_HM</i>	<i>Neptune-7_HM</i>	Neptune
<i>Penelope-7_HRo</i>		Penelope/Poseidon
<i>Penelope-7_LMi</i>		Penelope/Poseidon
<i>Penelope-7_LVa</i>		Penelope/Poseidon
<i>Penelope-7_NV</i>	<i>Neptune-7_NV</i>	Neptune
<i>Penelope-7_PH</i>		Penelope/Poseidon
<i>Penelope-7_SSa</i>	<i>Neptune-7_SSa</i>	Neptune
<i>Penelope-7_XL</i>	<i>Neptune-7_XL</i>	Neptune
<i>Penelope-7_XT</i>		Penelope/Poseidon
<i>Penelope-80_LMi</i>		Penelope/Poseidon
<i>Penelope-81_LMi</i>		Penelope/Poseidon
<i>Penelope-82_LMi</i>		Penelope/Poseidon
<i>Penelope-83_LMi</i>		Penelope/Poseidon
<i>Penelope-84_LMi</i>		Penelope/Poseidon
<i>Penelope-85_LMi</i>		Penelope/Poseidon
<i>Penelope-86_LMi</i>		Penelope/Poseidon
<i>Penelope-87_LMi</i>		Penelope/Poseidon
<i>Penelope-88_LMi</i>		Penelope/Poseidon
<i>Penelope-89_LMi</i>		Penelope/Poseidon
<i>Penelope-8_ACar</i>	<i>Neptune-8_ACar</i>	Neptune
<i>Penelope-8_BTa</i>		Penelope/Poseidon
<i>Penelope-8_CoFl</i>		Penelope/Poseidon
<i>Penelope-8_FoCa</i>		Penelope/Poseidon
<i>Penelope-8_HM</i>		Hydra
<i>Penelope-8_HRo</i>		Penelope/Poseidon
<i>Penelope-8_LMi</i>		Penelope/Poseidon
<i>Penelope-8_LVa</i>		Penelope/Poseidon
<i>Penelope-8_NV</i>	<i>Neptune-8_NV</i>	Neptune
<i>Penelope-8_PH</i>		Penelope/Poseidon
<i>Penelope-8_SSa</i>	<i>Neptune-8_SSa</i>	Neptune
<i>Penelope-8_XL</i>	<i>Neptune-8_XL</i>	Neptune
<i>Penelope-8_XT</i>	<i>Neptune-8_XT</i>	Neptune
<i>Penelope-90_LMi</i>		Penelope/Poseidon
<i>Penelope-91_LMi</i>		Penelope/Poseidon
<i>Penelope-92_LMi</i>		Penelope/Poseidon
<i>Penelope-93_LMi</i>		Penelope/Poseidon
<i>Penelope-94N1_LMi</i>		Penelope/Poseidon
<i>Penelope-94_LMi</i>		Penelope/Poseidon
<i>Penelope-95_LMi</i>		Penelope/Poseidon
<i>Penelope-96_LMi</i>		Penelope/Poseidon
<i>Penelope-97_LMi</i>		Penelope/Poseidon
<i>Penelope-98_LMi</i>		Penelope/Poseidon
<i>Penelope-99_LMi</i>		Penelope/Poseidon
<i>Penelope-9_ACar</i>	<i>Neptune-9_ACar</i>	Neptune
<i>Penelope-9_CoFl</i>		Penelope/Poseidon
<i>Penelope-9_FoCa</i>		Penelope/Poseidon

<i>Penelope-9_HM</i>		Hydra
<i>Penelope-9_HRo</i>		Penelope/Poseidon
<i>Penelope-9_LMi</i>		Penelope/Poseidon
<i>Penelope-9_LVa</i>		Penelope/Poseidon
<i>Penelope-9_NV</i>	<i>Neptune-9_NV</i>	Neptune
<i>Penelope-9_PH</i>		Penelope/Poseidon
<i>Penelope-9_XL</i>	<i>Neptune-9_XL</i>	Neptune
<i>Penelope-9_XT</i>	<i>Neptune-9_XT</i>	Neptune
<i>Penelope-N10_XL</i>	<i>Neptune-N10_XL</i>	Neptune
<i>Penelope-N12_XL</i>	<i>Neptune-N12_XL</i>	Neptune
<i>Penelope-N13_XL</i>	<i>Neptune-N13_XL</i>	Neptune
<i>Penelope-N14_XL</i>	<i>Neptune-N14_XL</i>	Neptune
<i>Penelope-N15B_XL</i>	<i>Neptune-N15B_XL</i>	Neptune
<i>Penelope-N15_XL</i>	<i>Neptune-N15_XL</i>	Neptune
<i>Penelope-N16_XL</i>		unclassified
<i>Penelope-N17_XL</i>		unclassified
<i>Penelope-N18_XL</i>	<i>Neptune-N18_XL</i>	Neptune
<i>Penelope-N19_XL</i>	<i>Neptune-N19_XL</i>	Neptune
<i>Penelope-N1_NGe</i>	<i>Neptune-N1_NGe</i>	Neptune
<i>Penelope-N1_PH</i>		Penelope/Poseidon
<i>Penelope-N1_XL</i>	<i>Neptune-N1_XL</i>	Neptune
<i>Penelope-N1_XT</i>	<i>Neptune-N1_XT</i>	Neptune
<i>Penelope-N20_XL</i>		unclassified
<i>Penelope-N21_XL</i>		unclassified
<i>Penelope-N22_XL</i>	<i>Neptune-N22_XL</i>	Neptune
<i>Penelope-N23_XL</i>		unclassified
<i>Penelope-N2_XL</i>	<i>Neptune-N2_XL</i>	Neptune
<i>Penelope-N3_XL</i>	<i>Neptune-N3_XL</i>	Neptune
<i>Penelope-N447_AMi</i>	<i>Neptune-N447_AMi</i>	Neptune
<i>Penelope-N4_XL</i>		unclassified
<i>Penelope-N5_XL</i>	<i>Neptune-N5_XL</i>	Neptune
<i>Penelope-N6_XL</i>	<i>Neptune-N6_XL</i>	Neptune
<i>Penelope-N7_XL</i>	<i>Neptune-N7_XL</i>	Neptune
<i>Penelope-N8_XL</i>	<i>Neptune-N8_XL</i>	Neptune
<i>Penelope-N9_XL</i>	<i>Neptune-N9_XL</i>	Neptune
<i>Penelope1A_XT</i>	<i>Neptune1A_XT</i>	Neptune
<i>Penelope1B_XT</i>	<i>Neptune1B_XT</i>	Neptune
<i>Penelope1C_XT</i>	<i>Neptune1C_XT</i>	Neptune
<i>Penelope1D_XT</i>	<i>Neptune1D_XT</i>	Neptune
<i>Penelope1N_CPB</i>	<i>Neptune1N_CPB</i>	Neptune
<i>Penelope1_Ci</i>		Penelope/Poseidon
<i>Penelope1_Dw</i>		Penelope/Poseidon
<i>Penelope1_XT</i>	<i>Neptune1_XT</i>	Neptune
<i>Penelope2_Dw</i>		Penelope/Poseidon
<i>Penelope2_XT</i>	<i>Neptune2_XT</i>	Neptune
<i>Penelope3_XT</i>	<i>Neptune3_XT</i>	Neptune
<i>Penelope4_XT</i>	<i>Neptune4_XT</i>	Neptune
<i>Penelope_Ele2</i>		Penelope/Poseidon
<i>Perere2_Smed</i>		Penelope/Poseidon
<i>Perere_Smed</i>		Penelope/Poseidon
<i>Poseidon-10_HM</i>		Penelope/Poseidon
<i>Poseidon-1B_PM</i>		Penelope/Poseidon
<i>Poseidon-1C_PM</i>		Penelope/Poseidon
<i>Poseidon-1D_PM</i>		Penelope/Poseidon
<i>Poseidon-1E_PM</i>		Penelope/Poseidon
<i>Poseidon-1F_PM</i>		Penelope/Poseidon
<i>Poseidon-1G_PM</i>		Penelope/Poseidon
<i>Poseidon-1H_PM</i>		Penelope/Poseidon
<i>Poseidon-1I_PM</i>		Penelope/Poseidon
<i>Poseidon-1J_PM</i>		Penelope/Poseidon
<i>Poseidon-1K_PM</i>		Penelope/Poseidon
<i>Poseidon-1N1_PM</i>		Penelope/Poseidon
<i>Poseidon-1N2_PM</i>		Penelope/Poseidon
<i>Poseidon-1_PM</i>		Penelope/Poseidon
<i>Poseidon-2B_PM</i>		Penelope/Poseidon
<i>Poseidon-2C_PM</i>		Penelope/Poseidon
<i>Poseidon-2D_PM</i>		Penelope/Poseidon
<i>Poseidon-2_HM</i>		Penelope/Poseidon
<i>Poseidon-2_PM</i>		Penelope/Poseidon
<i>Poseidon-3B_PM</i>		Penelope/Poseidon
<i>Poseidon-3_HM</i>		Penelope/Poseidon

<i>Poseidon-3_PM</i>		Penelope/Poseidon
<i>Poseidon-4_HM</i>		Penelope/Poseidon
<i>Poseidon-4_PM</i>		Penelope/Poseidon
<i>Poseidon-5_HM</i>		Penelope/Poseidon
<i>Poseidon-6_HM</i>		Penelope/Poseidon
<i>Poseidon-N1_PM</i>		Penelope/Poseidon
<i>Poseidon-N2_PM</i>		Penelope/Poseidon
<i>Poseidon-N3B_PM</i>		Penelope/Poseidon
<i>Poseidon-N3_PM</i>		Penelope/Poseidon
<i>Poseidon-N4_PM</i>		Penelope/Poseidon
<i>Poseidon-N5_PM</i>		Penelope/Poseidon
<i>Poseidon-N6_PM</i>		Penelope/Poseidon
<i>Poseidon_Ac</i>		Penelope/Poseidon
<i>Poseidon_Ap</i>		Penelope/Poseidon
<i>Poseidon_Hyd</i>		Penelope/Poseidon
<i>Pt1</i>	<i>Coprina_Pt1</i>	Coprina
<i>Q_As</i>	<i>Athena-Q_As</i>	Athena
<i>Q_Av</i>	<i>Athena-Q_Av</i>	Athena
<i>R0_As</i>	<i>Athena-R0_As</i>	Athena
<i>REP6_XT</i>		Neptune
<i>R_Av</i>	<i>Athena-R_Av</i>	Athena
<i>S0_Av</i>	<i>Athena-S0_Av</i>	Athena
<i>S_Av</i>	<i>Athena-S_Av</i>	Athena
<i>Sm1</i>	<i>Coprina_Sm1</i>	Coprina
<i>Sm2</i>	<i>Coprina_Sm2</i>	Coprina
<i>T1_As</i>	<i>Athena-T1_As</i>	Athena
<i>T2_As</i>	<i>Athena-T2_As</i>	Athena
<i>T3_As</i>	<i>Athena-T3_As</i>	Athena
<i>TE-3_XT</i>		Neptune
<i>TE-5_LVa</i>		Penelope/Poseidon
<i>TE-6_LVa</i>		Penelope/Poseidon
<i>T_Av</i>	<i>Athena-T_Av</i>	Athena
<i>UCON13</i>		Neptune
<i>W1_As</i>	<i>Athena-W1_As</i>	Athena
<i>W1_Av</i>	<i>Athena-W1_Av</i>	Athena
<i>W2_As</i>	<i>Athena-W2_As</i>	Athena
<i>W2_Av</i>	<i>Athena-W2_Av</i>	Athena
<i>W_As</i>	<i>Athena-W_As</i>	Athena
<i>W_Av</i>	<i>Athena-W_Av</i>	Athena
<i>YJ_As</i>	<i>Athena-YJ_As</i>	Athena
<i>YW_As</i>	<i>Athena-YW_As</i>	Athena