ZONAL DEFINITIONS

Descriptions of Low Latitude Zones

QUATERNARY

BUCCINOSPHAERA INVAGINATA Range-Zone (= NR1)

(Nigrini, 1971)

Defined by the range of *Buccinosphaera invaginata.* This is the uppermost Quaternary zone. The base of the zone is coincident with the upper limit of the *Collosphaera tuberosa* Zone.

Reference slides **R 1.1, R 1.2** and **R 1.3** from Sample 85-573-1-1, 8-10 cm

QUATERNARY

COLLOSPHAERA TUBEROSA Interval-Zone (= NR2/ NR3*)

(Nigrini, 1971, who termed it a 'Concurrent Range Zone')

The top of the zone is defined by the morphotypic first appearance of *Buccinosphaera invaginata* and is coincident with the lower limit of the *Buccinosphaera invaginata* Zone.

Events included in the zone are:

- Tm *Stylatractus universus (= Axoprunum angelinum)*

The base of the zone is defined by the morphotypic first appearance of *Collosphaera tuberosa* and is coincident with the upper limit of the *Amphirhopalum ypsilon* Zone.

* In the tropical Indian Ocean, Johnson et al. (1989) used the upper limit of *Stylatractus universus* to divide this zone into two zones, *Collosphaera tuberosa* (NR2) and *Stylatractus universus* (NR3).

Reference slides **R 2.1, R 2.2** and **R 2.3** from Sample 85-573-2-3, 130-131 cm.

QUATERNARY

AMPHIRHOPALUM YPSILON Interval-Zone (= NR4)

(Nigrini, 1971, who termed it an 'Assemblage Zone')

The top of the zone is defined by the morphotypic first appearance of *Collosphaera tuberosa* and is coincident with the lower limit of the *Collosphaera tuberosa* Zone.

Events included in the zone are:

- Tm *Pterocorys campanula*
- Bm *Pterocorys hertwigii*

The base of the zone is defined by the morphotypic last appearance of *Anthocyrtidium angulare* and is coincident with the upper limit of the *Anthocyrtidium angulare* Zone.

Reference slides **R 3.1, R 3.2** and **R 3.3** from Sample 85-573-2-CC.

QUATERNARY

ANTHOCYRTIDIUM ANGULARE Interval-Zone (= NR5)

(Nigrini, 1971, who termed it a 'Concurrent Range Zone')

The top of the zone is defined by the morphotypic last appearance of *Anthocyrtidium angulare* and is coincident with the lower limit of the *Amphirhopalum ypsilon* Zone.

Events included in the zone are:

- Bm *Lamprocyrtis nigriniae*

- Tm *Lamprocyrtis neoheteroporos*

The base of the zone is defined by the morphotypic last appearance of *Pterocanium prismatium* and is coincident with the upper limit of the *Pterocanium prismatium* Zone.

Reference slides **R 4.1, R 4.2** and **R 4.3** from Sample 85-573-3-CC.

PLIOCENE

PTEROCANIUM PRISMATIUM Interval-Chronozone (= NR6/ NR7*)

(Riedel and Sanfilippo, 1970, *emend.* 1978a, *emend.* Sanfilippo et al.,1985)

The top of the zone is defined by the morphotypic last appearance of *Pterocanium prismatium* and is coincident with the lower limit of the *Anthocyrtidium angulare* Zone. This zonal boundary is approximately equivalent to the Pliocene-Pleistocene boundary.

Events included in the zone are:

- Bm *Anthocyrtidium angulare*
- Tm *Theocorythium vetulum*
- Bm *Lamprocyrtis neoheteroporos*
- Bm *Theocorythium trachelium trachelium*

The base of the zone is defined by the morphotypic last appearance of *Stichocorys peregrina* and is coincident with the upper limit of the *Stichocorys peregrina* Zone.

The suggested use of the evolutionary transition from *Lamprocyrtis neoheteroporos* to *L. nigriniae (*formerly *L. haysi)* to define the top of this zone (Riedel and Sanfilippo, 1978a) has proven to be unsatisfactory. That event is commonly no more reliably recognizable than the morphotypic top of *P. prismatium,* and it frequently occurs as high as the *Amphirhopalum ypsilon* Interval-zone. Therefore we revert to using the morphotypic top of *P. prismatium,* which coincides with the lower limit of the *Anthocyrtidium angulare* Interval-zone. (Sanfilippo et al., 1985)

* In the tropical Indian Ocean, Johnson et al. (1989) used the upper limit of *Anthocyrtidium jenghisi* (Streeter, 1988, p.63, pl.1, figs.1-4) to divide this zone into two zones, *Pterocanium prismatium* (NR6) and *Anthocyrtidium jenghisi* (NR7).

Reference slides **R 5.1, R 5.2** and **R 5.3** from Sample 85-572-5-3, l30-131 cm.

PLIOCENE

SPONGASTER PENTAS Interval-Chronozone (= NR8/NR9/NR10*)

(Riedel and Sanfilippo, 1970, *emend.* 1978a)

The top of the zone is defined by the morphotypic last occurrence of *Stichocorys peregrina* and is coincident with the lower limit of the *Pterocanium prismatium* Zone.

Events included in the zone are:

- *Didymocyrtis avita* -> *Didymocyrtis tetrathalamus*
- Tm *Phormostichoartus fistula*
- Tm *Lychnodictyum audax*
- Tm *Phormostichoartus doliolum*
- Bm *Amphirhopalum ypsilon*
- *Spongaster pentas* -> *Spongaster tetras tetras*
- *Didymocyrtis penultima* -> *Didymocyrtis avita;* Bm *Theocorythium vetulum*
- The lower limit of the zone is approximately synchronous with Bm *Pterocanium prismatium;* Tm *Solenosphaera omnitubus omnitubus;* Tm *Solenosphaera omnitubus procera*

The base of the zone is defined by the evolutionary transition from *Spongaster berminghami* to *Spongaster pentas* and is coincident with the upper limit of the *Stichocorys peregrina* Zone.

* In the tropical Indian Ocean, Johnson et al. (1989) used the upper limits of *Phormostichoartus fistula* and *Phormostichoartus doliolum* to divide this zone into three zones, *Stichocorys peregrina* (NR8), *Phormostichoartus fistula* (NR9) and *Phormostichoartus doliolum* (NR10).

Reference slides **R 6.1, R 6.2** and **R 6.3** from Sample 85-573-8-3, 69-71 cm.

PLIOCENE/LATE MIOCENE

STICHOCORYS PEREGRINA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the evolutionary transition from *Spongaster berminghami* to *Spongaster pentas* and is coincident with the lower limit of the *Spongaster pentas* Zone.

Events included in this zone are:

- Bm *Botryostrobus aquilonaris;* Tm *Siphostichartus corona;* Bm *Pterocorys campanula*
- Tm *Acrobotrys tritubus;* Tm *Calocycletta caepa*
- Tm *Stichocorys johnsoni*
- Tm *Calocycletta cladara*

The base of the zone is defined by the evolutionary transition from *Stichocorys delmontensis* to *Stichocorys peregrina* and is coincident with the upper limit of the *Didymocyrtis penultima* Zone.

The upper part of this zone is equivalent to Zone NR11 (*Anthocyrtidium prolatum* Nigrini and Caulet, 1988, p.355, pl.2, figs.7-10) as defined by Johnson et al., 1989 for the tropical Indian Ocean.

The Miocene-Pliocene boundary lies within this zone.

Reference slides **R 7.1, R 7.2** and **R 7.3** from Sample 85-573-10-CC; **R 8.1, R 8.2** and **R 8.3** from Sample 85-573-12-CC; **R 9.1, R 9.2** and **R 9.3** from Sample 85-573-13-4, 65-66 cm.

LATE MIOCENE

DIDYMOCYRTIS PENULTIMA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the evolutionary transition from *Stichocorys delmontensis* to *S. peregrina* and is coincident with the lower limit of the *Stichocorys peregrina* Zone.

Events included in the zone are:

- Bm *Solenosphaera omnitubus omnitubus;* Bm *Solenosphaera omnitubus procera*
- The lower limit of the zone is approximately synchronous with *Didymocyrtis antepenultima -> Didymocyrtis penultima*.

The base of the zone is defined by the morphotypic last appearance of *Diartus hughesi* and is coincident with the upper limit of the *Didymocyrtis antepenultima* Zone.

Reference slides **R 10.1, R 10.2** and **R 10.3** from Sample 85-573-14-3, 65-66 cm; **R 11.1, R 11.2** and **R 11.3** from Sample 85-573-15-CC.

LATE MIOCENE

DIDYMOCYRTIS ANTEPENULTIMA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the morphotypic last appearance of *Diartus hughesi* and is coincident with the lower limit of the *Didymocyrtis penultima* Zone.

Events included in the zone are:

- Tm *Dictyocoryne ontongensis;* Bm *Acrobotrys tritubus;* Tm *Botryostrobus miralestensis*
- Bm *Spongaster berminghami*
- The lower limit of the zone is approximately synchronous with *Didymocyrtis laticonus -> Didymocyrtis antepenultima*

The base of the zone is defined by the evolutionary transition from *Diartus petterssoni* to *Diartus hughesi* and is coincident with the upper limit of the *Diartus petterssoni* Zone.

Reference slides **R 12.1, R 12.2** and **R 12.3** from Sample 85-573-17-3, 61-62 cm; **R 13.1, R 13.2** and **R 13.3** from Sample 85-573-17-CC; **R 14.1, R 14.2** and **R 14.3** from Sample 85-573-18-CC.

MIDDLE MIOCENE

DIARTUS PETTERSSONI Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the evolutionary transition from *Diartus petterssoni* to *Diartus hughesi* and is coincident with the lower limit of the *Didymocyrtis antepenultima* Zone.

Events included in the zone are:

- *Lithopera neotera -> Lithopera bacca*
- Tm *Stichocorys wolffii* *
- Tm *Cyrtocapsella japonica;* Tm *Lithopera thornburgi*
- Tm *Cyrtocapsella cornuta;* Tm *Cyrtocapsella tetrapera*
- Tm *Carpocanopsis cristata*
- Bm *Phormostichoartus doliolum*
- The lower limit of the zone is approximately synchronous with Tm *Dorcadospyris alata;* Tm *Liriospyris parkerae;* Bm *Cyrtocapsella japonica*; *Calocycletta virginis* ->*Calocycletta cladara*

The base of the zone is defined by the morphotypic first appearance of *Diartus petterssoni* and is coincident with the upper limit of the *Dorcadospyris alata* Zone.

* In some Pacific Ocean samples the morphotypic last appearance of *Stichocorys wolffii is* below the morphotypic last appearance of *Cyrtocapsella cornuta* and the morphotypic first appearance of *Phormostichoartus doliolum.*

Reference slides **R 15.1, R 15.2** and **R 15.3** from Sample 85-573B-3-CC:
R 16.1, R 16.2 and **R 16.3** from Sample 85-573B-6-3, 61-63 cm.

MIDDLE MIOCENE

DORCADOSPYRIS ALATA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1971)

The top of the zone is defined by the morphotypic first appearance of *Diartus petterssoni* and is coincident with the lower limit of the *Diartus petterssoni* Zone.

Events included in the zone are:

- Tm *Carpocanopsis bramlettei*
- *Lithopera renzae* -> *Lithopera neotera*
- *Didymocyrtis mammifera* -> *Didymocyrtis laticonus*
- Bm *Lithopera thornburgi;* Bm *Phormostichoartus corbula;* Bm *Dictyocoryne ontongensis*
- Tm *Calocycletta costata;* Tm *Didymocyrtis tubaria;* Tm *Didymocyrtis violina;* Bm *Lithopera renzae*
- The lower limit of the zone is approximately synchronous with Tm *Dorcadospyris forcipata*

The base of the zone is defined by the evolutionary transition from *Dorcadospyris dentata* to *Dorcadospyris alata* and is coincident with the upper limit of the *Calocycletta costata* Zone.

Reference slides **R 17.1, R 17.2** and **R 17.3** from Sample 85-573B-9-2, 61-63 cm; **R 18.1, R 18.2** and **R 18.3** from Sample 85-573B-10-3, 61-63 cm.

EARLY MIOCENE

CALOCYCLETTA COSTATA Interval-Chronozone

(Riedel and Sanfilippo, 1970)

The top of the zone is defined by the evolutionary transition from *Dorcadospyris dentata* to *Dorcadospyris alata* and is coincident with the lower limit of the *Dorcadospyris alata* Zone.

Events included in the zone are:

- Tm *Eucyrtidium diaphanes*
- *Liriospyris stauropora -> Liriospyris parkerae*
- Tm *Carpocanopsis favosa*
- Tm *Didymocyrtis prismatica*
- Tm *Carpocanopsis cingulata;* Bm *Carpocanopsis cristata*
- The lower limit of the zone is approximately synchronous with Tm *Lychnocanoma elongata*

The base of the zone is defined by the morphotypic first appearance of *Calocycletta costata* and is coincident with the upper limit of the *Stichocorys wolffii* Zone.

Reference slides **R 20.1, R 20.2** and **R 20.3** from Sample 85-573B-123, 61-63 cm.; **R 21.1, R 21.2** and **R 21.3** from Sample 85-573B-13-CC.

EARLY MIOCENE

STICHOCORYS WOLFFII Interval-Chronozone

(Riedel and Sanfilippo, 1978a)

The top of the zone is defined by the morphotypic first appearance of *Calocyletta costata* and is coincident with the lower limit of the *Calocycletta costata* Zone.

Events included in the zone are:

- Bm *Didymocyrtis mammifera*
- Bm *Calocycletta caepa*
- Bm *Dorcadospyris dentata*
- Bm *Liriospyris stauropora*
- The lower limit is approximately synchronous with Tm *Dorcadospyris ateuchus;* Bm *Siphostichartus corona*

The base of the zone is defined by the morphotypic first appearance of *Stichocorys wolffii* and is coincident with the upper limit of the *Stichocorys delmontensis* Zone.

Reference slides **R 22.1, R 22.2** and **R 22.3** from Sample 85-573B-143, 61-63 cm.; **R 23.1, R 23.2** and **R 23.3** from Sample 85-573B-14-CC.

EARLY MIOCENE

STICHOCORYS DELMONTENSIS Interval-Chronozone

(Riedel and Sanfilippo, 1978a)

The top of the zone is defined by the morphotypic first appearance of *Stichocorys wolffii* and is coincident with the lower limit of the *Stichocorys wolffii* Zone.

The lower limit of the zone is approximately synchronous with the following events:

- Bm *Didymocyrtis tubaria;* Bm *Didymocyrtis violina;* Bm *Stichocorys delmontensis;* Bm *Carpocanopsis bramlettei*

The base of the zone is defined by the morphotypic last appearance of *Theocyrtis annosa* and is coincident with the upper limit of the *Cyrtocapsella tetrapera* Zone.

Reference slides **R 24.1, R 24.2** and **R 24.3** from Sample 85-573B-153, 61-63 cm.; **R 25.1, R 25.2** and **R 25.3** from Sample 85-573B-15-CC; **R 26.1, R 26.2** and **R 26.3** from Sample 85-573-16-CC.

EARLY MIOCENE

CYRTOCAPSELLA TETRAPERA Interval-Chronozone

(Riedel and Sanfilippo, 1978a)

The top of the zone is defined by the morphotypic last appearance of *Theocyrtis annosa* and is coincident with the lower limit of the *Stichocorys delmontensis* Zone.

Events included in the zone are:

- Tm *Calocycletta serrata*
- Bm *Eucyrtidium diaphanes*
- Tm *Calocycletta robusta*
- Bm *Carpocanopsis favosa*
- Bm *Cyrtocapsella cornuta*
- The lower limit of the zone is approximately synchronous with Bm *Calocycletta serrata;* Bm *Calocycletta virginis;* Tm *Artophormis gracilis;* Bm *Botryostrobus miralestensis*

The base of the zone is defined by the morphotypic first appearance of *Cyrtocapsella tetrapera* and is coincident with the upper limit of the *Lychnocanoma elongata* Zone.

Reference slides **R 27.1, R 27.2** and **R 27.3** from Sample 85-573B-17-3, 60-62 cm.

OLIGOCENE

LYCHNOCANOMA ELONGATA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the morphotypic first appearance of *Cyrtocapsella tetrapera* and is coincident with the lower limit of the *Cyrtocapsella tetrapera* Zone.

An event included in the zone is:

- Tm *Dorcadospyris papilio*

- The lower limit of the zone is approximately synchronous with Bm *Carpocanopsis cingulata*

The base of the zone is defined by the morphotypic first appearance of *Lychnocanoma elongata* and is coincident with the upper limit of the *Dorcadospyris ateuchus* Zone. This upper zonal boundary is approximately equivalent to the Oligocene-Miocene boundary.

Reference slides **R 28.1, R 28.2** and **R 28.3** from Sample 85-573B-19-CC; **R 29.1, R 29.2** and **R 29.3** from Sample 85-573B-20-CC.

OLIGOCENE

DORCADOSPYRIS ATEUCHUS Interval-Chronozone

(Riedel and Sanfilippo, 1971)

The top of the zone is defined by the morphotypic first appearance of *Lychnocanoma elongata* and is coincident with the lower limit of the *Lychnocanoma elongata* Zone.

Events included in the zone are:

- Bm *Calocycletta robusta*
- Bm *Dorcadospyris forcipata;* Tm *Lithocyclia angusta;* Tm *Lychnocanoma trifolium*
- Bm *Dorcadospyris papilio*
- Bm *Theocyrtis annosa*
- Bm *Lychnocanoma trifolium;* Tm *Theocyrtis tuberosa*
- The lower limit of the zone is approximately synchronous with Tm *Lithocyclia crux; Centrobotrys petrushevskayae -> Centrobotrys thermophila*

The base of the zone is defined by the evolutionary transition from *Tristylospyris triceros* to *Dorcadospyris ateuchus* and is coincident with the upper limit of the *Theocyrtis tuberosa* Zone.

Reference slides **R 30.1, R 30.2** and **R 30.3** from Sample 85-573B-21-CC; **R 31.1, R 31.2** and **R 31.3** from Sample 85-573B-22-CC; **R 32.1, R 32.2** and **R 32.3** from Sample 85-573B-33-CC.

OLIGOCENE

THEOCYRTIS TUBEROSA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1971, 1978a)

The top of the zone is defined by the evolutionary transition from *Tristylospyris triceros* to *Dorcadospyris ateuchus* and is coincident with the lower limit of the *Dorcadospyris ateuchus* Zone.

Events included in the zone are:

- Bm *Didymocyrtis prismatica;* Tm *Dorcadospyris pseudopapilio*
- Bm *Lychnodictyum audax*
- *Centrobotrys gravida -> Centrobotrys petrushevskayae;* Bm *Dorcadospyris pseudopapilio*
- Bm *Lithocyclia crux; Artophormis barbadensis ->Artophormis gracilis*
- Bm *Centrobotrys gravida*
- Tm *Dictyoprora pirum;* Bm *Phormostichoartus fistula*
- The lower limit of the zone is approximately synchronous with Tm *Cryptocarpium ornatum;* Tm *Dictyoprora mongolfieri;* Tm *Lychnocanoma amphitrite*

The base of the zone is defined by the evolutionary transition from *Lithocyclia aristotelis* group to *Lithocyclia angusta* and is coincident with the upper limit of the *Cryptocarpium ornatum* Zone.

Reference slides **R 33.1, R 33.2** and **R 33.3** from Sample 85-573B-34-CC; **R 34.1, R 34.2** and **R 34.3** from Sample 85-573B-35-CC; **R 35.1, R 35.2** and **R 35.3** from Sample 85-573B-37-CC.

LATE EOCENE

CRYPTOCARPIUM ORNATUM Interval-Chronozone

(Maurrasse and Glass, 1976)

The top of the zone is defined by the evolutionary transition of the *Lithocyclia aristotelis* group to *Lithocyclia angusta* and is coincident with the lower limit of the *Theocyrtis tuberosa* Zone.

Events included in this zone are:

- Tm *Dictyoprora armadillo*
- Tm *Lophocyrtis jacchia*
- Tm *Calocyclas turris;* Tm *Thyrsocyrtis bromia;* Tm *Thyrsocyrtis rhizodon;* Tm *Cryptocarpium azyx*
- The lower limit of the zone is approximately synchronous with Tm *Thyrsocyrtis lochites;* Tm *Calocyclas bandyca;* Tm *Calocyclas hispida;* Tm *Lychnocanoma bellum;* Tm *Podocyrtis papalis*

The base of the zone is defined by the mophotypic last appearance of *Thyrsocyrtis tetracantha* and is coincident with the upper limit of the *Calocyclas bandyca* Zone.

Reference slides **R 36.1, R 36.2** and **R 36.3** from Sample 41-366-10-5, 53-60 cm.

LATE EOCENE

CALOCYCLAS BANDYCA Interval-Chronozone

(Sanfilippo and Riedel in Saunders et al., 1985)

The top of the zone is defined by the mophotypic last appearance of *Thyrsocyrtis tetracantha* and is coincident with the lower limit of the *Cryptocarpium ornatum* Zone.

Events included in this zone are:

- Tm *Thyrsocyrtis triacantha*
- Bm *Theocyrtis tuberosa*
- Tm *Eusyringium fistuligerum*
- Tm *Podocyrtis goetheana*

The base of the zone is defined by the morphotypic first appearance of *Calocyclas bandyca* and is coincident with the upper limit of the *Cryptocarpium azyx* Zone.

Reference slides **R 37.1, R 37.2** and **R 37.3** from Sample 17-167-28-4, 107-112 cm.

MIDDLE/LATE EOCENE

CRYPTOCARPIUM AZYX Interval-Chronozone

(Sanfilippo and Riedel in Saunders et al., 1985)

The top of the zone is defined by the morphotypic first appearance of *Calocyclas bandyca* and is coincident with the lower limit of the *Calocyclas bandyca* Zone.

Events included in this zone are:

- Tm *Podocyrtis chalara*
- Bm *Lychnocanoma amphitrite*
- *Calocyclas hispida* -> *Calocyclas turris*

The base of the zone is defined by the morphotypic first appearance of *Cryptocarpium azyx* and is coincident with the upper limit of the *Podocyrtis goetheana* Zone.

Reference slides **R 38.1, R 38.2** and **R 38.3** from Sample 8-69A-10-6, 130-132 cm.

MIDDLE EOCENE

PODOCYRTIS GOETHEANA Interval-Chronozone

(Moore, 1971, *emend.* Riedel and Sanfilippo, 1978a)

The top of the zone is defined by the morphotypic first appearance of *Cryptocarpium azyx* and is coincident with the lower limit of the *Cryptocarpium azyx* Zone.

Events included in the zone are:

- Tm *Spongatractus pachystylus*
- Bm *Thyrsocyrtis bromia*
- Bm *Thyrsocyrtis tetracantha;* Bm *Dictyoprora pirum;* Tm *Theocotylissa ficus*
- Tm *Sethochytris triconiscus*
- Bm *Dictyoprora armadillo*
- The lower limit of the zone is approximately synchronous with *Lithocyclia ocellus* group -> *Lithocyclia aristotelis* group

The base of the zone is defined by the morphotypic first appearance of *Podocyrtis goetheana* and is coincident with the upper limit of the *Podocyrtis chalara* Zone.

Reference slides **R 39.1, R 39.2** and **R 39.3** from Sample 16-162-6-2, 126-134 cm.

MIDDLE EOCENE

PODOCYRTIS CHALARA Interval-Chronozone

(Riedel and Sanfilippo, 1970)

The top of the zone is defined by the morphotypic first appearance of *Podocyrtis goetheana* and is coincident with the lower limit of the *Podocyrtis goetheana* Zone.

Event included in the zone is:

- Tm *Podocyrtis trachodes*

- The lower limit of the zone is approximately synchronous with Tm *Phormocyrtis striata striata;* Bm *Tristylospyris triceros*

The base of the zone is defined by the evolutionary transition from *Podocyrtis mitra* to *Podocyrtis chalara* and is coincident with the upper limit of the *Podocyrtis mitra* Zone.

Reference slides **R 40.1, R 40.2** and **R 40.3** from Sample 16-162-8-3, 83-89 cm.

MIDDLE EOCENE

PODOCYRTIS MITRA Interval-Chronozone

(Riedel and Sanfilippo, 1970)

The top of the zone is defined by the evolutionary transition from *Podocyrtis mitra* to *Podocyrtis chalara* and is coincident with the lower limit of the *Podocyrtis mitra* Zone.

Events included in the zone are:

- Bm *Cryptocarpium ornatum*
- Tm *Podocyrtis ampla*
- Tm *Eusyringium lagena;* Bm *Artophormis barbadensis;* Bm *Thyrsocyrtis lochites;* Bm *Sethochytris triconiscus;* Tm *Podocyrtis fasciolata;* Tm *Podocyrtis helenae*

The base of the zone is defined by the evolutionary transition from *Podocyrtis sinuosa* to *Podocyrtis mitra* and is coincident with the upper limit of the *Podocyrtis ampla* Zone.

Reference slides **R41.1, R41.2** and **R41.3** from Sample 10-94-17-1, 121-128 cm.

MIDDLE EOCENE

PODOCYRTIS AMPLA Interval-Chronozone

(Riedel and Sanfilippo, 1970)

The top of the zone is defined by the evolutionary transition from *Podocyrtis sinuosa* to *Podocyrtis mitra* and is coincident with the lower limit of the *Podocyrtis mitra* Zone.

Events included in the zone are:

- Bm *Podocyrtis trachodes*
- Tm *Podocyrtis dorus*
- *Eusyringium lagena* -> *Eusyringium fistuligerum*
- Bm *Podocyrtis fasciolata;* Bm *Podocyrtis helenae*
- The lower limit of the zone is approximately synchronous with Tm *Theocotyle venezuelensis*

The base of the zone is defined by the evolutionary transition from *Podocyrtis phyxis* to *Podocyrtis ampla* and is coincident with the upper limit of the *Thyrsocyrtis triacantha* Zone.

Reference slides **R 42.1, R 42.2** and **R 42.3** from Sample 10-94-18-4, 109-117 cm.

MIDDLE EOCENE

THYRSOCYRTIS TRIACANTHA Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the evolutionary transition from *Podocyrtis phyxis* to *Podocyrtis ampla* and is coincident with the lower limit of the *Podocyrtis ampla* Zone.

Events included in the zone are:

- Bm *Eusyringium fistuligerum*
- Tm *Theocotyle nigriniae;* Tm *Theocotyle conica; Podocyrtis diamesa -> Podocyrtis phyxis;* Tm *Theocorys anaclasta;* Tm *Lamptonium fabaeforme constrictum;* Tm *Lamptonium fabaeforme chaunothorax;* Tm *Thyrsocyrtis hirsuta;* Tm *Thyrsocyrtis robusta*
- The lower limit of the zone is approximately synchronous with *Thyrsocyrtis tensa -> Thyrsocyrtis triacantha*

The base of the zone is defined by the morphotypic first appearance of *Eusyringium lagena* and is coincident with the upper limit of the *Dictyoprora mongolfieri* Zone.

Reference slides **R 43.1, R 43.2** and **R 43.3** from Sample 10-94-20-2, 70-77 cm.

MIDDLE EOCENE

DICTYOPRORA MONGOLFIERI Interval-Chronozone

(Riedel and Sanfilippo, 1970, *emend*. 1978a)

The top of the zone is defined by the morphotypic first appearance of *Eusyringium lagena* and is coincident with the lower limit of the *Thyrsocyrtis triacantha* Zone.

Events included in the zone are:

- Tm *Lamptonium fabaeforme fabaeforme;* Bm *Podocyrtis dorus*
- *Theocotyle cryptocephala* -> *Theocotyle conica*
- The lower limit of the zone is approximately synchronous with Tm *Calocycloma castum*

The base of the zone is defined by the morphotypic first appearance of *Dictyoprora mongolfieri* and is coincident with the upper limit of the *Theocotyle cryptocephala* Zone.

Reference slides **R 44.1, R 44.2** and **R 44.3** from Sample 10-94-22-3, 44-52 cm.

MIDDLE EOCENE

THEOCOTYLE CRYPTOCEPHALA Interval-Chronozone

(Foreman, 1973)

The top of the zone is defined by the morphotypic first occurrence of *Dictyoprora mongolfieri* and is coincident with the lower limit of the *Dictyoprora mongolfieri* Zone.

Events included in the zone are:

- *Podocyrtis acalles -> Podocyrtis sinuosa*
- Bm *Thyrsocyrtis robusta*
- Bm *Theocotyle venezuelensis*
- The lower limit of the zone is approximately synchronous with Tm *Buryella clinata*

The base of the zone is defined by the evolutionary transition from *Theocotyle nigriniae* to *Theocotyle cryptocephala* and is coincident with the upper limit of the *Phormocyrtis striata striata* Zone.

Reference slides **R 45.1, R 45.2** and **R 45.3** from Sample 10-94-25-3, 95-102 cm.

EARLY/MIDDLE EOCENE

PHORMOCYRTIS STRIATA STRIATA Interval-Chronozone

(Foreman, 1973, *emend.* Riedel and Sanfilippo, 1978a)

The top of the zone is defined by the evolutionary transition from *Theocotyle nigriniae* to *Theocotyle cryptocephala* and is coincident with the lower limit of the *Theocotyle cryptocephala* Zone.

Events included in the zone are:

- *Spongatractus balbis -> Spongatractus pachystylus*
- Tm *Lamptonium sanfilippoae*
- Bm *Thyrsocyrtis rhizodon*
- Bm *Podocyrtis diamesa*
- The lower limit of the zone is approximately synchronous with Bm *Lamptonium fabaeforme constrictum; Phormocyrtis striata exquisita -> Phormocyrtis striata striata;* Bm *Podocyrtis acalles;* Tm *Phormocyrtis cubensis;* Bm *Lychnocanoma bellum*

The base of the zone is defined by the morphotypic first appearance of *Theocorys anaclasta* and is coincident with the upper limit of the *Buryella clinata* Zone.

Reference slides **R 46.1, R 46.2** and **R 46.3** from Sample 10-94-28-1, 110-117 cm.

EARLY EOCENE

BURYELLA CLINATA Interval-Chronozone

(Foreman, 1973, *emend.* Foreman, 1975)

The top of the zone is defined by the morphotypic first appearance of *Theocorys anaclasta* and is coincident with the lower limit of the *Phormocyrtis striata striata* Zone.

Events included in the zone are:

- Tm *Pterocodon ampla;* Tm *Bekoma bidartensis;* Tm *Buryella tetradica;* Tm *Thyrsocyrtis tarsipes*
- Bm *Lithocyclia ocellus* group; Bm *Thyrsocyrtis tensa; Theocotylissa alpha -> Theocotylissa ficus*
- Bm *Calocyclas hispida*
- The lower limit of the zone is approximately synchronous with Bm *Spongatractus balbis;* Bm *Lamptonium sanfilippoae;* Bm *Theocotyle nigriniae;* Bm *Thyrsocyrtis hirsuta*

The base of the zone is defined by the evolutionary transition from *Pterocodon? anteclinata* to *Buryella clinata* and is coincident with the upper limit of the *Bekoma bidartensis* Zone.

Reference slides **R 47.1, R 47.2** and **R 47.3** from Sample 143-384-6-3, 102-109 cm.

EARLY EOCENE/PALEOCENE

BEKOMA BIDARTENSIS Interval-Chronozone

(Foreman, 1973)

The top of the zone is defined by the evolutionary transition from *Pterocodon? anteclinata* to *Buryella clinata* and is coincident with the lower limit of the *Buryella clinata* Zone.

Events included in the zone are:

- Bm *Theocotylissa alpha*
- Bm *Lamptonium fabaeforme chaunothorax*
- Bm *Pterocodon ? anteclinata;* Bm *Lophocyrtis jacchia*
- Bm *Calocycloma castum; Lamptonium pennatum -> Lamptonium fabaeforme fabaeforme*
- Bm *Podocyrtis papalis*
- Tm *Bekoma campechensis*

The base of the zone is defined by the morphotypic first appearance of *Bekoma bidartensis* and is coincident with the upper limit of the *Bekoma campechensis* Zone.

Reference slides **R 48.1, R 48.2** and **R 48.3** from Sample 43-384-7-6, 119-125 cm.

PALEOCENE

BEKOMA CAMPECHENSIS Zone

(Nishimura, 1987)

The top of the zone is defined by the morphotypic first appearance of *Bekoma bidartensis* and is coincident with the lower limit of the *Bekoma bidartensis* Zone.

Events included in the zone are:

- Bm *Phormocyrtis cubensis*
- Tm *Buryella pentadica*
- Bm *Pterocodon ampla*

The base of the zone is defined by the morphotypic first appearance of *Bekoma campechensis* and is underlain by unzoned Paleocene. Events in this unzoned portion of the Paleocene include Bm *Lamptonium pennatum* and Bm *Buryella pentadica*.

Reference slides **R 49.1, R 49.2** and **R 49.3** from Sample 43-384-7-6, 119-125 cm.