

Taxonomic backbone databases for fossil and living marine microplankton

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on behalf of
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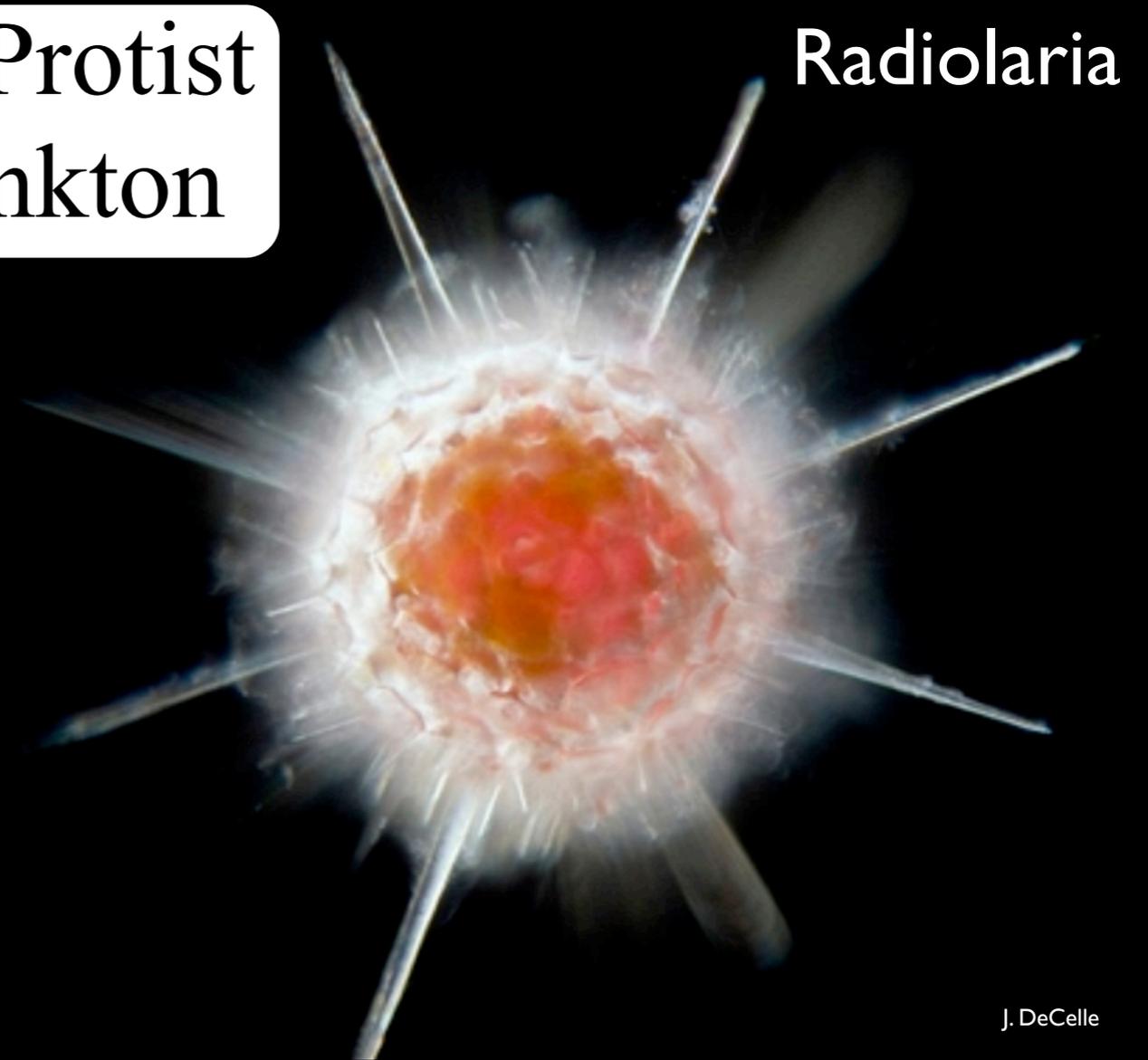
The logo for Leibniz, featuring the word "Leibniz" in a stylized, cursive script.

Fossilising Protist Marine plankton



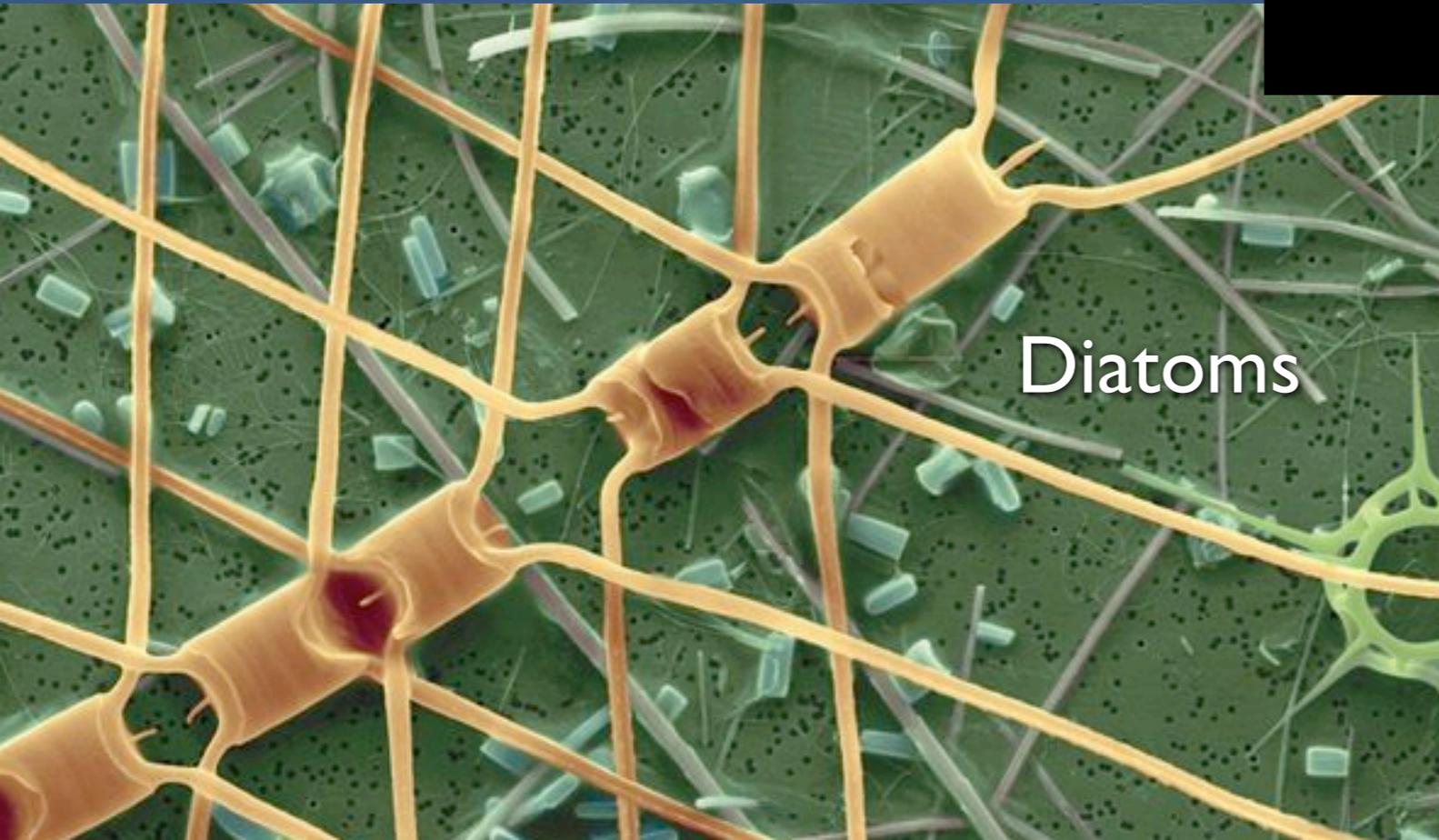
Foraminifera

J. DeCelle

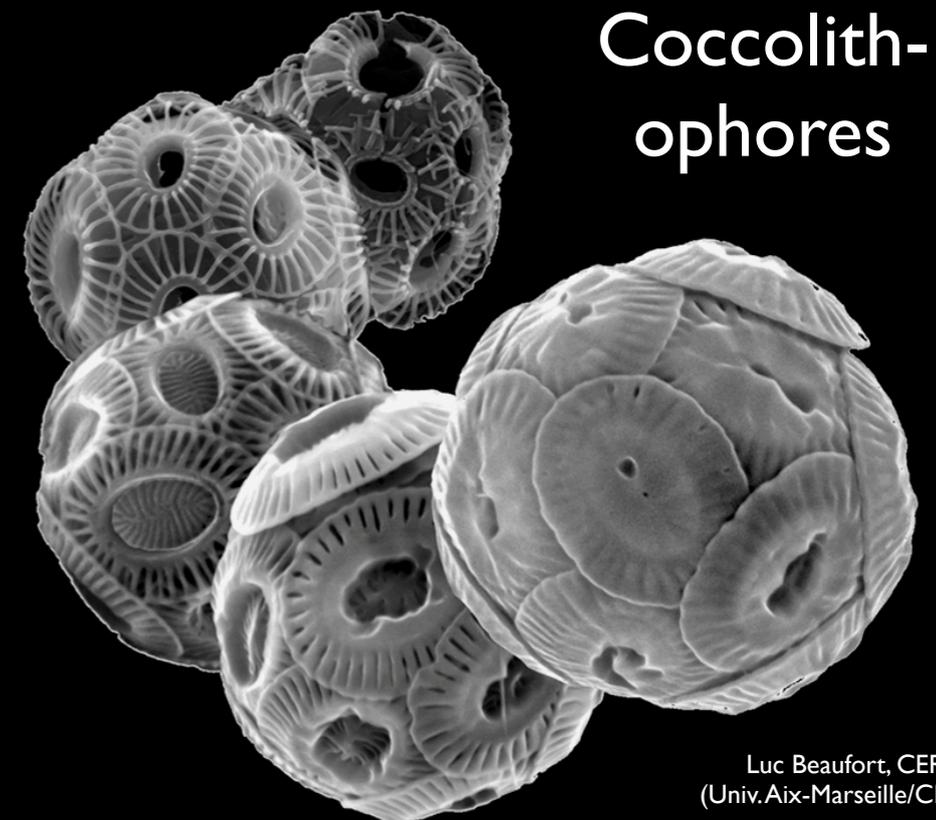


Radiolaria

J. DeCelle



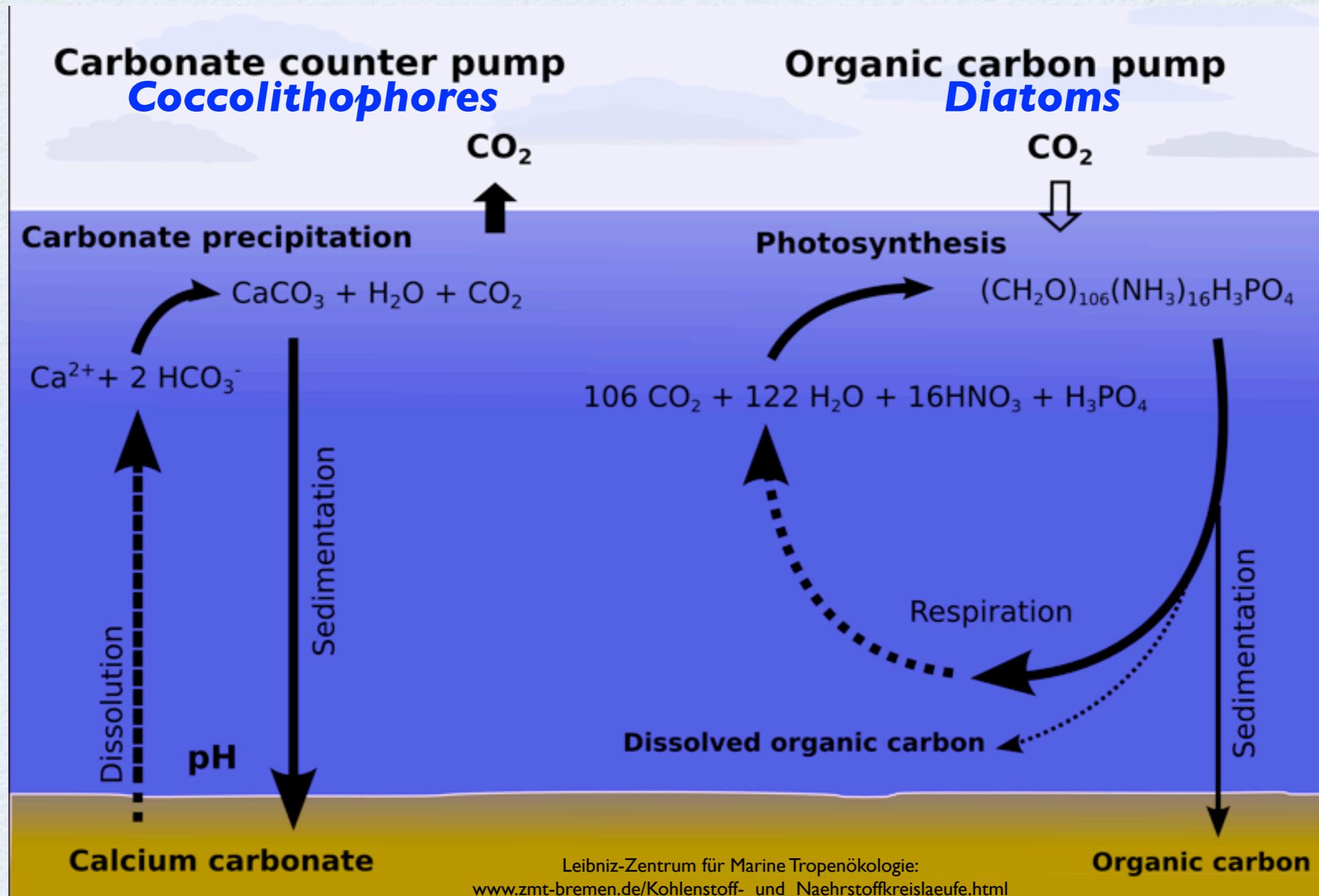
Diatoms



Coccolithophores

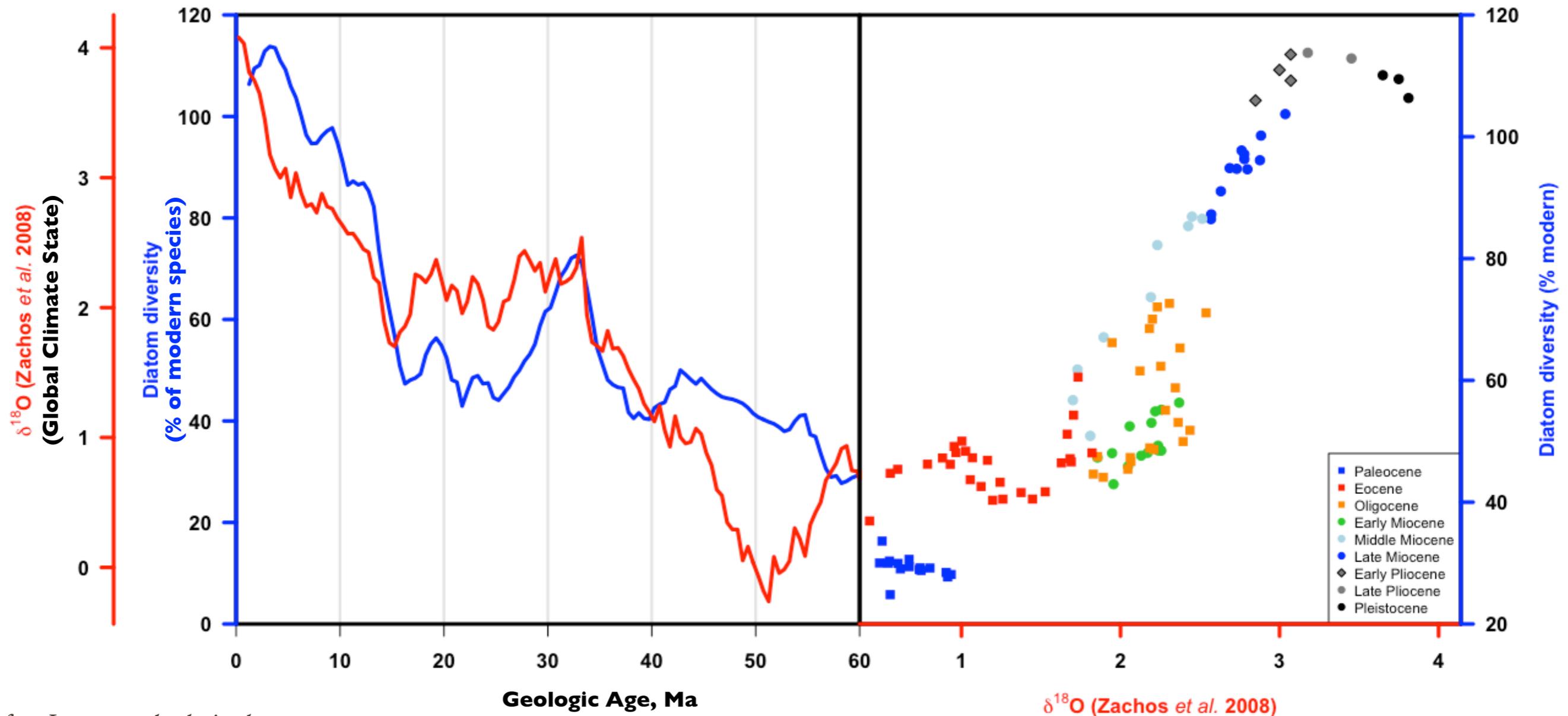
Luc Beaufort, CEREGE
(Univ. Aix-Marseille/CNRS)

Ocean Phytoplankton and the Carbon Cycle



- Coccolithophores and Diatoms together make up nearly 1/2 global carbon cycle
- Over periods < ca 10,000 years, only diatoms remove excess carbon from system

Diatom Diversity and Climate: a study from Fossils



- Diversity and climate strongly correlated (raw $\rho=.92$, detrended $r=.6$, $p<.001$)
- Late/Mid Miocene (5-15 Ma) diversity significantly lower (up to 30%)
- Late/Mid Miocene pCO_2 in range of projected future global warming climate
- If late/mid Miocene oceans are analog to future warm oceans then equilibrium future ocean diatom diversity may be lower *[substantial extinction risk]*

Micropaleontology in the Oil Industry



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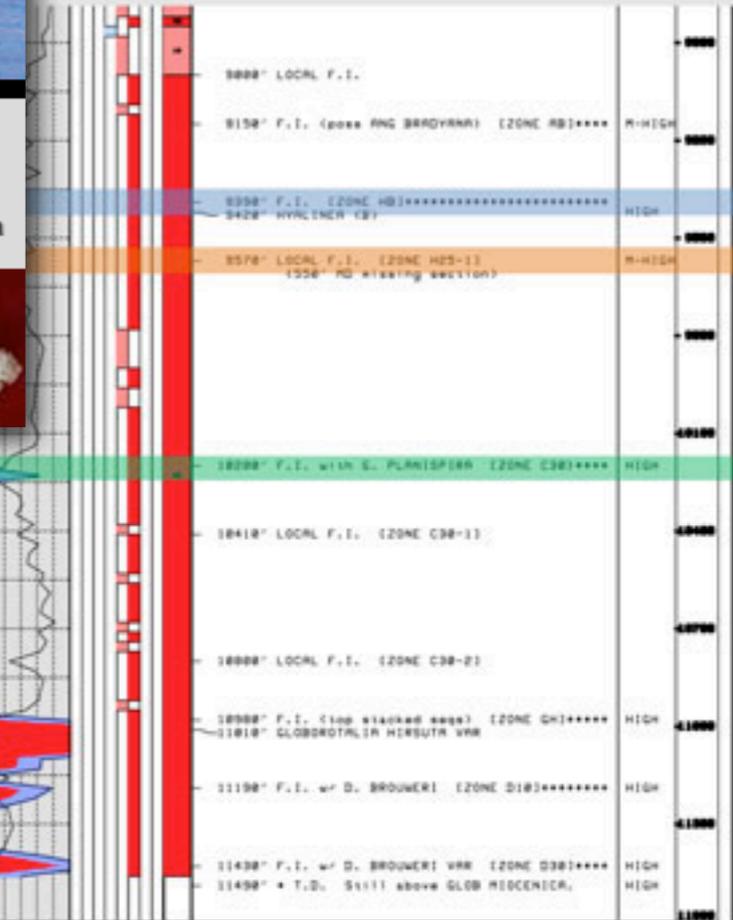


Wellsite Paleontology



Mexico Example

Well #4

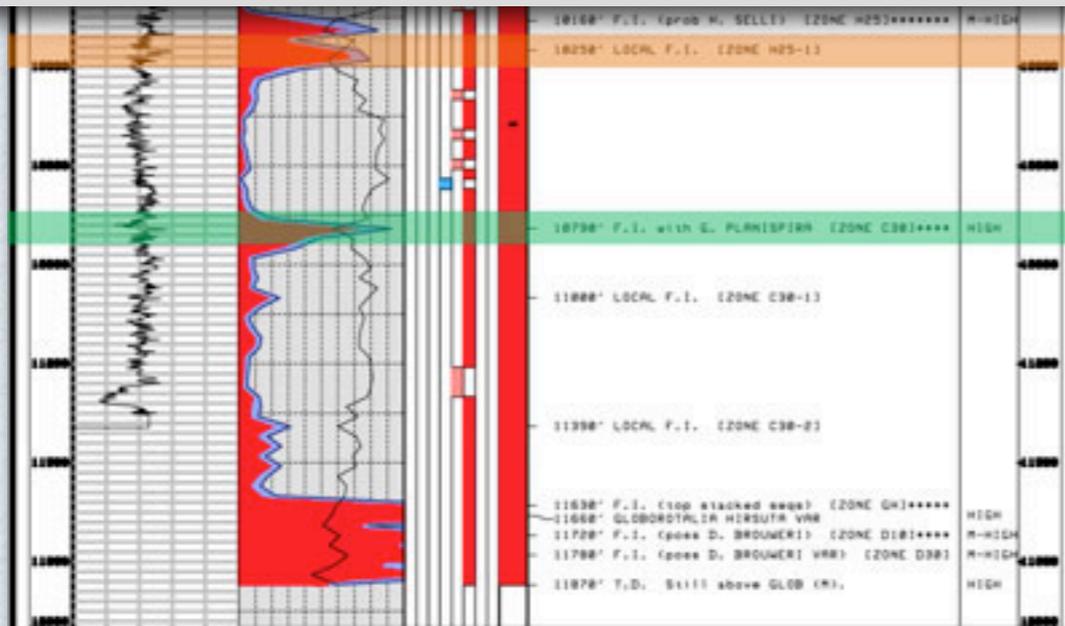


Foraminifera



Wellsite Paleontology

Ellington & Associates, Inc. fully appreciates the importance of paleontology as a primary tool for determination of stratigraphic position, relative dating, and correlation. We are the leaders in providing contract and well site paleontologists to the oil and gas industry and have an outstanding reputation in the field. Our staff has many years of analytical and operational experience, and we have strong bonds and long-term relationships with many of the largest players in industry.



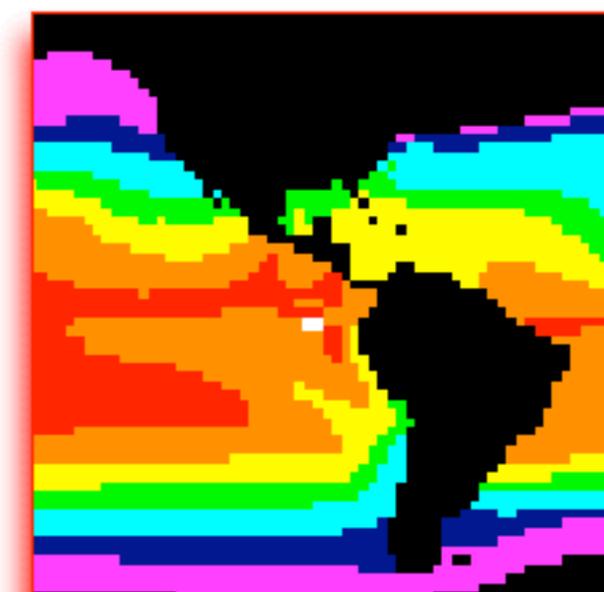
Zone H25-1
G. Planispira

Applied Data is linked to names: example from paleoclimate research

CLIMAP 18KYrBP Sea Surface Temperature Reconstructions

CLIMAP 18,000 Years Before Present August Sea Surface Temperature Reconstruction, [Map](#) or [Data](#).

CLIMAP 18,000 Years Before Present February Sea Surface Temperature Reconstruction, [Map](#) or [Data](#).



1428	PACIF. RC 11210	RAD	43	17													
1429	SPONU.SP.	SPONU.CF	ELLIP.A.ARC.	+	A.MED.ACT.	LEPTO.											
1430	CENO. CRIST.	ECHI. LEPTO.	P.ANT. +	P.TTN.E.ELE.	+	E.FUR.											
1431	POLY. FLAMM.	HELI. ASTER.	HYME. EUCLI.		LARCS.QUADR.												
1432	OMTAR.TETRA.	LITH. MINOR	SPIR. MELON.		STYLC.ASTER.												
1433	POLY. LAPPA.	DICTC.TRUNC.	DICTC.PROFU.		EUCH. TRIAN.												
1434	S.T.IR +	S.T.TESTYLD.VALID.	HEXPY.SPP.		O.STE. +	T.OCT.											
1435	LIRIO.RETIC.	ANTH. OPHIR.	CARPS.SPP.		PTCOR.MINYT.												
1436	GIRA. ANGUL.	PHSPY.STABI.	SCAPH	PTCAN.KOROT.	P.P.EU +	P.P.PR											
1437	D.CRI. +	D.HIR.BTSTR.	AQUIL.	THECL.DAVIS.	THECL.DAVIS.CORNU.												
1438	THECL.BICOR.	SKIRT	THECL.BICOR.	PTCOR.ZANCL.	THECR	TRACH	TRACH.										
1439	ANTA. DENTI.	CYLIN.ANTA.	DENTI.	ANTA. STREL.													
1440	'(A4, 1X, 15(1X, A4)/5X, 15(1X, A4)/5X, 13(1X, A4))'																
1441	172.	0.4	0.2	0.4	0.0	0.0	0.0	0.0	2.5	0.0	2.0	0.2	0.2	3.5	0.6	0.0	
1442		1.8	0.6	3.3	0.6	0.4	0.8	0.0	0.2	15.3	0.8	0.2	1.8	0.2	1.2	0.2	
1443		0.0	1.0	0.0	0.4	0.4	0.0	0.0	0.4	0.6	0.8	0.0	0.0	0.0			
1444	174.	0.0	0.0	0.2	0.0	0.0	0.0	0.0	2.0	0.0	0.9	0.0	0.4	1.8	0.4	0.2	
1445		2.2	0.0	0.7	0.2	0.2	0.9	0.0	1.1	21.2	1.1	0.4	1.3	0.2	1.1	0.2	

- Fragment of data used by CLIMAP in ground-breaking study of past glacial ocean climates, ca 1980
- 1/4 names used in this study now have different names

Mis-Identifications Damage Quality of Applied Research Results

- Named taxa represent other data in analyses, based on ecologic preferences of the species:
 - Water temperature
 - Nutrients and productivity
 - Water depth
- Incorrect names introduce incorrect values for these other data into analysis
- Incorrect conclusions e.g. about global warming, or likely presence of oil can result

Taxonomic Catalogs

(previously, printed monographs,
today digitally online)

Reference - [Add synonym and reference](#)

Abelmann, A. and Gowing, M.M., 1997b. Spatial distribution pattern of living polycystine radiolarian taxa - baseline study for paleoenvironmental reconstructions in the Southern Ocean (Atlantic sector). *Marine Micropaleontology*, vol. 30: 3-28.

Anderson, O.R., 1983a. *Radiolaria*. Springer-Verlag, New York, 355 pp.

Benson, R.N., 1966. Recent Radiolaria from the Gulf of California. Ph.D. thesis, University of Minnesota, 577 pp.

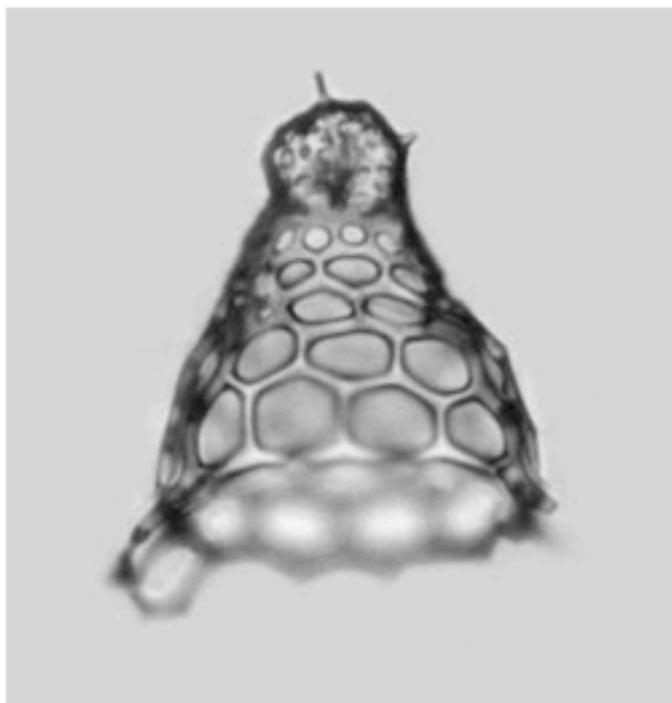
Bjørklund, K. R. and Ciesielski, P. F., 1994. Ecology, morphology, stratigraphy, and the paleoceanographic significance of *Cycladophora davisiana davisiana*. Part I: Ecology and morphology. *Marine Micropaleontology*, vol. 24: 71-88.

Bjørklund, K.R., 1976a. Radiolaria from the Norwegian Sea, Leg 38 of the Deep Sea Drilling Project. Initial Reports of the Deep Sea Drilling Project. Washington (U.S. Government Printing Office), vol. 38: 1101-1168.

[Radiolaria.org](#) | [Home](#) > [Cenozoic](#) > [Holocene \(Recent\)](#) > [Sea of Japan](#) >

[Radiolaria.org](#) | [Home](#) > [Cenozoic](#) > [Holocene \(Recent\)](#) > [Sea of Japan](#) >

[List species](#)



Cycladophora davisiana Ehrenberg, 1862

Description - [Add description](#)

Shell conical-campanulate, of moderately heavy structure, consisting of two, three or four segments. Cephalis subglobose, with small, sparse pores, and bearing two short, acicular spines - one vertical, approximately apical, and the other lateral, oblique. Collar stricture slight. Subsequent part of shell, comprising its main bulk,

[Description](#)

[Images](#)

[Synonyms](#)

[References](#)

[Distribution](#)

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Cycladophora davisiana

Synonym - [Add synonym and reference](#)

1862 *Cycladophora* (?) *davisiana* - Ehrenberg p. 297

1862 *Pterocodon davisianus* - Ehrenberg pp. 300-301

1862 *Pterocanium davisianus* - Haeckel p. 332

1862 *Eucyrtidium davisianum* - Haeckel pp. 328-329

1873 *Pterocodon davisianus* - Ehrenberg pl. 2, fig. 10

1873 *Cycladophora* (?) *davisiana* - Ehrenberg pl. 2, fig. 11

1887 *Stichopilium davisianum* - Haeckel pp. 1437-1438

1899 *Stichopilium davisianum* - Cleve p. 33; pl. 4, fig. 6

1958 *Theocalyptra davisiana* - Riedel p. 239; pl. 4, figs. 2-3; textf

1966 *Theocalyptra davisiana* - Benson pl. 29, figs. 14-16

1967 *Cycladophora davisiana* - Petrushevskaya pp. 120-122; fig

1971 *Cycladophora davisiana* - Ling et al. pl. 2, figs. 6-7

1974 *Cycladophora davisiana* - Lozano fig. 4 (22)

1975 *Cycladophora davisiana* - Molina-Cruz p. 131; not figured

1975 *Cycladophora davisiana* - Robertson not figured

1976 *Cycladophora davisiana* - Bjørklund pl. 11, figs. 9-10

1977 *Dinorthis davisiana* - Kruppova p. 92, figs. 4-5; p. 96, fi

Photo#: 1386

Location: Japan Sea

Sample: GH99-N1, 1000-2000m

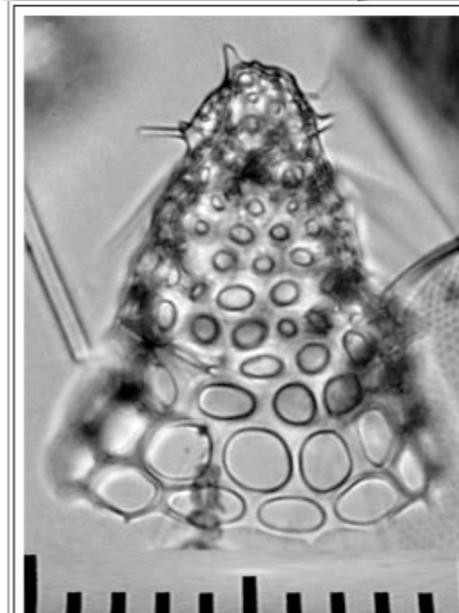
Latitude: 42°52'N

Longitude: 145°55'E

Photo by: T. Itaki

Comments:

Plankton sample. Scale is 100 μ m.



a-Cruz pl. 7, fig. 19
and Hays not figured
and Moore pl. 24, figs. 2a
iana - Morley p. 206; pl.
on fig. 1.8f
and Hays not figured
and Stepien pl. 2, fig. 3
oy and Riedel pl. 5, fig. 1
ky and Morley pl. 4, fig.
nd and Ciesielski fig. 2;
ki and Bjørklund not fig
er-Ritzrau pl. 7, figs. 15-
Paverd p. 234; pl. 70, figs
- Welling pp. 240-241; p
nn and Gowing p. 22
nd et al. pl. 2, fig. 6
fig. 15-121

Why are taxonomic backbone databases needed?

***Cycladophora davisiana* - an important stratigraphic marker and paleoceanographic indicator species**

1862 *Cycladophora* (?) *davisiana* - Ehrenberg p. 297

1862 *Pterocodon davisianus* - Ehrenberg pp. 300-301

1862 *Pterocanium davisianus* - Haeckel p. 332

1862 *Eucyrtidium davisianum* - Haeckel pp. 328-329

1887 *Stichopilium davisianum* - Haeckel pp. 1437-1438

1958 *Theocalyptra davisiana* - Riedel p. 239; pl. 4, figs. 2-3; textfig. 10

1967 *Cycladophora davisiana* - Petrushevskaya pp. 120-122; fig. 69

1973 *Clathrocyloma davisiana* - Dumitrica p. 837; pl. 24, fig. 7

1977 *Diplocyclas davisiana* - Kruglikova p. 92, figs. 4-5; p. 96, figs. 19-23

1980 *Cycladophora davisiana* var. *davisiana* - Morley p. 206; pl. 1, figs. 1-5

1996 *Cycladophora davisiana davisiana* - Welling pp. 240-241; pl. 23, fig. 9

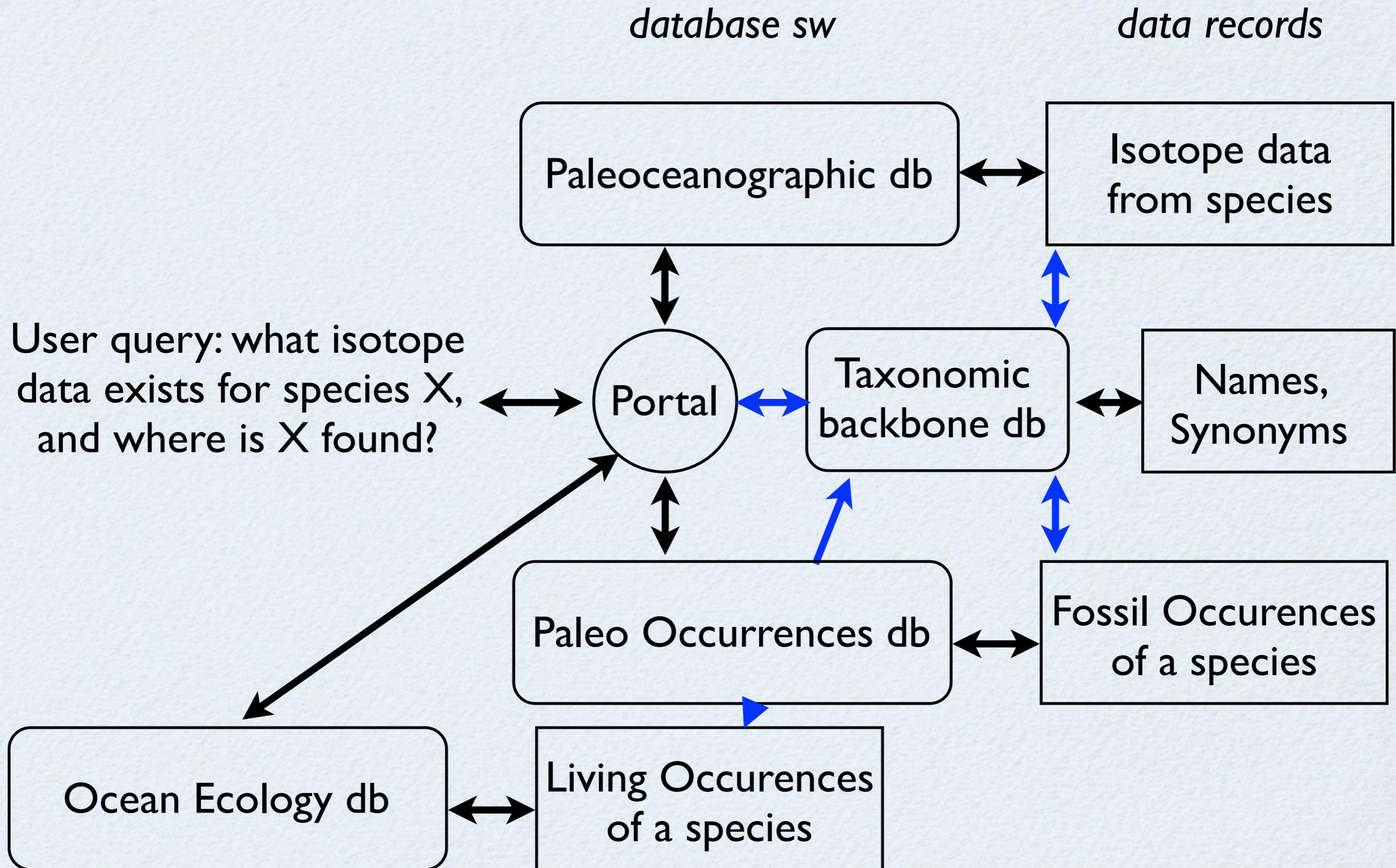
- *Corythospyris davisiana davisiana* - ODP Janus db transcription error

A Cross-Reference List for Taxonomic Names

	A	B	E	F
1	valid_name	radorg_family_name	taxon_name	taxon_status
1258	Cycladophora davisiana	Theoperidae	Cycladophora davisiana	V
1259	Cycladophora davisiana	Theoperidae	Cycladophora davisiana davisiana	S
1260	Cycladophora davisiana	Theoperidae	Theocalyptra davisiana	S
1261	Cycladophora davisiana	Theoperidae	Diplocyclas davisiana	S
1262	Cycladophora davisiana	Theoperidae	Theocalyptra davisiana	S
1263	Cycladophora davisiana	Theoperidae	Clathrocycloma davisiana	S
1264	Cycladophora davisiana	Theoperidae	Corythospyris davisiana davisiana	S
1265	Cycladophora golli	Theoperidae	Cycladophora golli	V
1266	Cycladophora golli	Theoperidae	Cycladophora golli golli	S
1267	Cycladophora golli	Theoperidae	Cycladophora regipileus	S
1268	Cycladophora golli	Theoperidae	Cycladophora golli regipileus	S
1269	Cycladophora golli	Theoperidae	Lophocyrtis golli	S
1270	Cycladophora golli	Theoperidae	Lophocyrtis regipileus	S
1271	Cycladophora golli	Theoperidae	C. g. regipileus	S

(Here, two species of radiolarians)

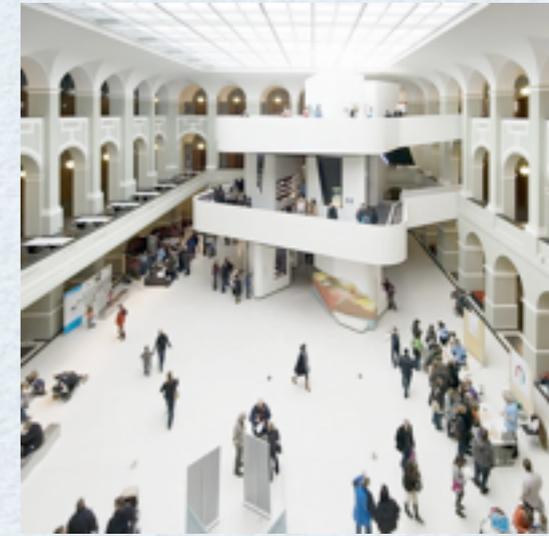
Taxonomic Backbones



Neptune/NSB

www.chronos.org or 212.201.100.111

- Initiated in early 1990s as local database by Lazarus & ETH team, as marine micropaleontologic counterpart to Sepkoski db & to fill gap in ODP capabilities (Janus shipboard data only, mostly raw data archive)
 - Recast (ca 2005) as standard sql internet database by Chronos Iowa (Cervato, Diver, Fils and others)
 - ‘Curation only’ version at COL



ETH, Zürich



Ames, Iowa



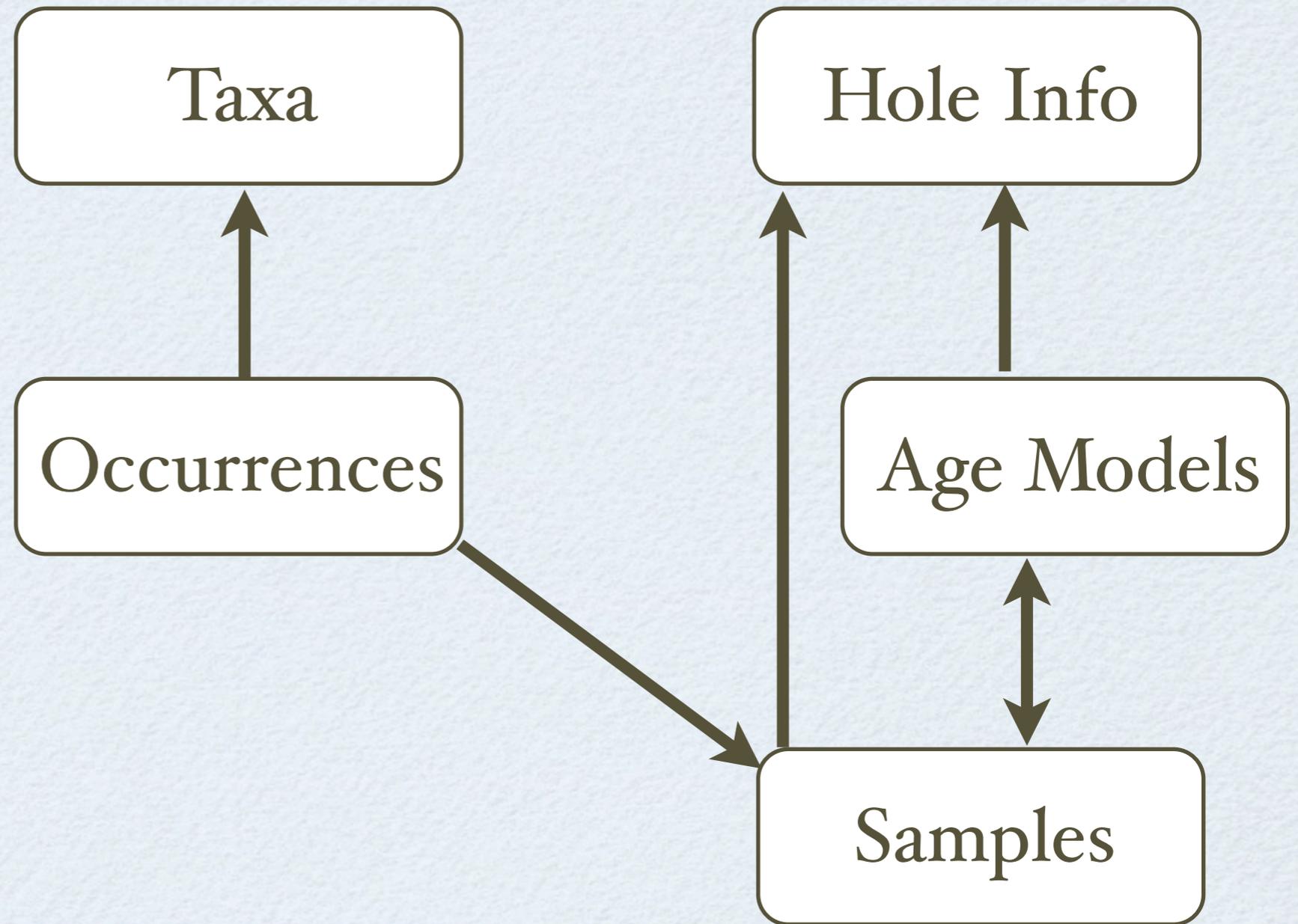
MfN Berlin



- ‘Researcher’ version NSB (for ‘Neptune Sandbox Berlin’) initiated 2010 by Lazarus and Diver w. funding from CEES Oslo (Stenseth, Liow)
- Neptune used in >40 ISI publications, including several in *Nature*, *Science* and *PNAS*

Basic Structure of Neptune

- Occurrences of species in samples
- Additional location etc info in Holes table
- Age models auto-calculate ages for each sample
- Multiple samples per age model, each hole can have multiple age models
- Only one GPTS scale used for all models internally



Neptune Taxonomy

- Atomic name components, including concept (Author/Year)
- Simple equal/distinct, global relations
- Content based on IODP supported initial TNL
- Additional development needed

Species Names
DSDP Code
Group
Genus
Species
Subspecies
Validity
Synonymous To
Author
Date
Comments

The diagram illustrates the structure of the Neptune Taxonomy data model. It consists of a vertical stack of fields. The top field is 'Species Names', which is highlighted in white. Below it are ten other fields, each with a different shade of gray: 'DSDP Code', 'Group', 'Genus', 'Species', 'Subspecies', 'Validity', 'Synonymous To', 'Author', 'Date', and 'Comments'. Two arrows originate from the right side of the 'DSDP Code' and 'Synonymous To' fields and point towards the 'Species Names' field, indicating that these fields are used to identify or link to the species names.

NSB Database uses a 'TNL' to understand taxonomy

Neptune database - Search

192.168.101.133/search

Wikipedia Amazon.de Google News Apple Berlin External science sites Rad sites MfN sites MfN webmail

Neptune database - Search

[About](#) [Search](#) [Downloaded datasets](#) [Help](#)

Neptune AND BOX SBerlin



Search the database

Fossil group	<input type="text" value="Radiolarians"/>	Time span	<input type="text"/>	to	<input type="text"/>	Ma	Ocean	<input type="text"/>
Genus	<input type="text" value="Cycladophora"/>	Longitude	<input type="text"/>	to	<input type="text"/>	°	Leg	<input type="text"/>
Species	<input type="text" value="davisiana"/>	Latitude	<input type="text"/>	to	<input type="text"/>	°	Site	<input type="text"/>

Options

- Resolve taxonomy using TNL
- Transform age scale from Berggren *et al.* 1995 to Gradstein *et al.* 2004.
- Perform pacman trimming (top : % ; bottom : %).

Username Password

IODP TNL Project

- Multiple institutions, platforms in IODP; continued problems with paleontology data management led to 2006 Houston meeting on IODP paleontology data
- Paleontology Coordination Group (PCG) formed, first meeting 2007 Berlin.
 - *Advisory function, community and IODP staff as co-chairs*
- Goals - improve paleontologic data entry, data management, data quality within all aspects of IODP

Taxonomic Name Lists (TNLs)

- First priority for PCG : creation of scientifically useful taxonomic name lists for IODP databases, data-entry applications, etc.
- Current IODP taxonomy data undocumented mixture of valid names, synonyms, open-nomenclature, misspellings, etc without any quality control
- Community editors/teams found for planktonic foraminifera, calcareous nannofossils, diatoms and radiolarians, dinoflagellates, contracts signed fall 2008; final lists now ~ready

Project head
David Lazarus

IT Services
Patrick Diver

IODP PCG cochairs
Jamus Collier
Hiroshi Kawamura
Emmanuel Söding

PCG members

Yoshiaki Aita
Susanne Feist-Burkhardt
Brian Huber
Masao Iwai
Jackie Lees
Noritoshi Suzuki
Ellen Thomas
Woody Wise

Additional taxonomic work

Fumio Akiba
Jean-Pierre Caulet
Jane Dolven
Dave Harwood
Kris Hooks
Annika Sanfilippo
Itsuki Suto



Dave Lazarus



Nori Suzuki



Pat Diver



Masao Iwai



Kris Hooks



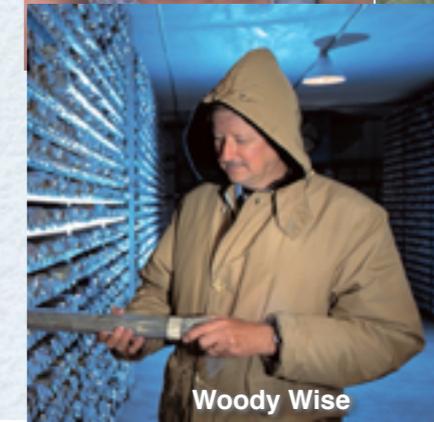
Brian Huber



Jackie Lees



Jeremy Young



Woody Wise



Susanne Feist-Burkhardt

TNL Features



IODP
INTEGRATED OCEAN
DRILLING PROGRAM

- Covers all names reported in DSDP or ODP
- Each name's status given (valid, synonym, subspecies, open-nomenclature, misspelling, higher taxon, etc) [partially from Neptune, updated by specialists]
- Synonyms/misspellings/subspecies linked to valid taxon name (newly entered if not present)
- Author/year for all valid taxa names
- NOT an attempt to impose 'authorised' taxonomy (user can alter output) but to make some sense out of names chaos in raw data
- *Will replace older lists in NSB, allow better data exchange between IODP, Neptune, PBDB etc, improve data entry/quality within IODP*

Practice - Editing a Record

Grab File Edit Capture Window Help

Anthocyrts ovata Haeckel 1887.jpg

Untitled @radnames3.public (UppMInpostgres)

Searching "pal_lit"

ovata Haeckel

Query Builder Query Editor

'XovataX' and author like 'HaeckelX'

species_name	radorg_family_na	synon_to	neptune_id	taxon_status	synon_to_old	author	publ_yr	comments
ovata	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovatum	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovatum	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovata	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovata	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovatum	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovatum	[Null]	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
ovatus	Spongodiscidae	0	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
[Null]	Tripodiscium or Tripodiscium	ovatum	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
[Null]	Lychnocanoma	Lychnocanoma	ovatum	[Null]	[Null]	Haeckel	1887	N: J::: No:
N	Dictyoprora ov: Dictyoprora	ovata	RDICA0040	V	[Null]	(Haeckel) Nigrini	1977	N: J::: No:
[Null]	Lithocampium or Lithocampium	ovata	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:
[Null]	Lithocampe ov: Lithocampe	ovata	[Null]	[Null]	[Null]	Haeckel	1887	N: J::: No:

select * from trlnames where species_name like 'XovataX' and author like 'HaeckelX'

0.14 sec elapsed

Record 24 of 27

longitudinal rows of circular to subcircular pores which are hexagonally framed. Pores are uniform in size and arrangement, 12-15 on a half equator at the widest part of thorax. Mouth very slightly constricted, with a well-developed poreless peristome and 8-9 stout, flat, blunt or point-terminal teeth which are directed inwards or downwards; terminal teeth are bifurcated. Pointed subterminal teeth (10) may also be present, but are never as well-developed as the terminal teeth.

Measurements: Length of apical horn 25-50 μ; of cephalis 25-30 μ; of thorax 80-105 μ. Maximum breadth of thorax 65-70 μ.

Anthocyrts ovata HAECKEL 1887, p. 1272, pl. 62, fig. 13.

Sethocomus trochus (Ehrenberg) POPOFSKY 1917, p. 273, text-figs. 36, 37.

Anthocyrtsidium cineraria Haeckel RIEDEL 1957, p. 84 (partim).

Anthocyrtsidium ovata (Haeckel) PETRUSHEVSKAYA and KOSLOVA 1972, p. 545, pl. 36, fig. 10.

Our western tropical Pacific and Indian Ocean sites. It is absent from our central Pacific site. F.A.D. occurs at about 4.6 Ma and L.A.D. at about 3.9 Ma. Rare.

Geographic range and abundance: Rare in both tropical Indian and tropical Pacific Ocean sediments.

Phylogeny: Unknown.

Anthocyrtsidium zanguebaricum (Ehrenberg) Plate 2, figure 11

Anthocyrts zanguebarica EHRENBERG 1872a, p. 301.—EHRENBERG 1872b, pl. 9, fig. 12.

Anthocyrtsidium zanguebaricum (Ehrenberg) HAECKEL 1887, p. 1299, pl. 62, fig. 9.—NIGRINI 1967, p. 58, pl. 6, fig. 4.—RENZ 1974, pl. 19, fig. 17.—PETRUSHEVSKAYA 1974, p. 85, fig. 2-1.—RENZ 1976, p. 143, pl. 6, fig. 18.—PETRUSHEVSKAYA 1976, pl. 1, fig. A.—NIGRINI and MOORE 1979, p. N69, pl. 25, fig. 2.—BOLTOVSKOY and RIEDEL 1980, p. 127, text-fig. 6.—MOLINA-CRUZ 1982, p. 996, pl. 4, fig. 2.

Sethocyrtis oxycephalis HAECKEL 1887, p. 1299, pl. 62, fig. 9.

Anthocyrts ovata HAECKEL 1887, p. 1272, pl. 62, fig. 13.

Sethocomus trochus (Ehrenberg) POPOFSKY 1917, p. 273, text-figs. 36, 37.

Anthocyrtsidium cineraria Haeckel RIEDEL 1957, p. 84 (partim).

Anthocyrtsidium ovata (Haeckel) PETRUSHEVSKAYA and KOSLOVA 1972, p. 545, pl. 36, fig. 10.

17349 records in page 1

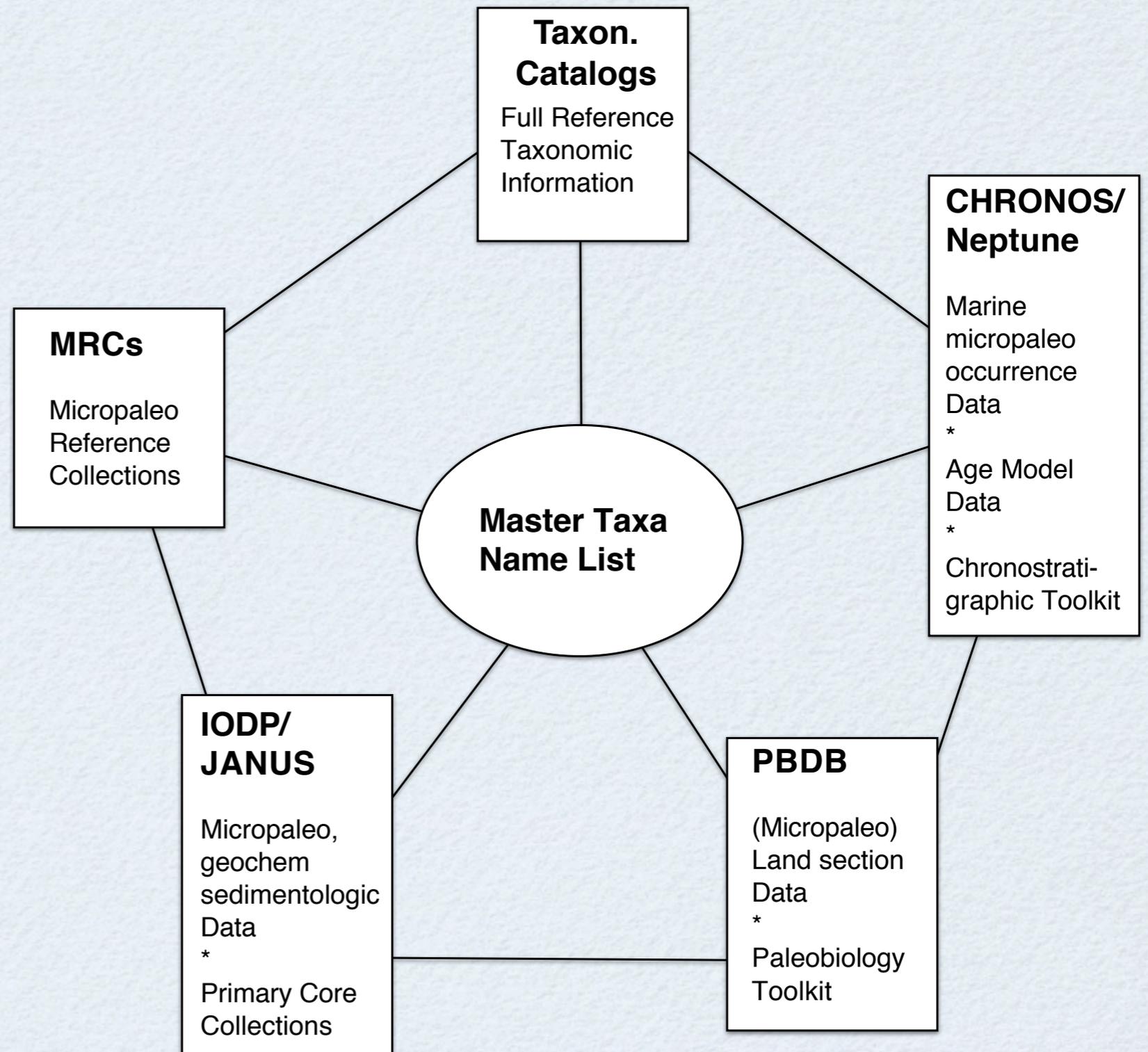
www.radolan.com | Holocene (Recent) | Gulf of California

Radiolarian TNL, 'final'

	<i>Original</i>	<i>Final</i>	<i>N change</i>	<i>%change</i>
<i>Total Records</i>	17 155	17 348	193	1,13
<i>Status records</i>	3 416	4 260	844	24,71
<i>Valid species</i>	1 164	1 639	475	40,81
Recent		421		
Neogene		393		
Paleogene		469		
Mesozoic		356		
<i>Synonyms</i>	643	975	332	51,63
<i>Generic</i>	466	821	355	76,18
<i>Unknown</i>	740	345	-395	-53,38
<i>Questionable</i>	388	417	29	7,47
<i>Subspecies*</i>	0	24	24	(-)
<i>Incorrect group</i>	2	39	37	(-)

Long-term goal: Federated Database Structures

- Federated system for managing deep-sea micropaleontology data
- All individual dbs exist, a few are provisionally linked
- Central TNL db manages a 'key field' for meaningful data exchange
- Central TNL db development started but on hold (\$)



Summary

Our new effort will

- provide a complete taxonomic list of marine microfossils and their living representatives
- finish the technology development to support this list (core db system; editorial website, name-service to external users)
- substantially improve the quality of data used in research by IODP, community research databases e.g. Neptune; EOL; WoRMS
- eventually provide online catalogs for those groups still lacking these (e.g. diatoms, benthic foraminifera), or for which catalogs are still seriously incomplete (radiolaria, planktonic foraminifera)