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二叠纪-三叠纪礁相房室海绵演化与灭绝*

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提要　就礁相房室海绵而言,早二叠世的物种数最少,中二叠世的分异度最高,晚二叠世的其次,中三叠世的较少,卡尼期的增多,诺利期的更多。礁相房室海绵的演化反映出二叠纪 - 三叠纪有 3 次灭绝事件,分别发生在中二叠世末期、长兴期末期、卡尼期末期。这 3 次灭绝事件的规模各不相同:中二叠世末期的灭绝事件规模较小,它使 83.8 %的中二叠世礁相房室海绵种灭绝;长兴期末期的灭绝规模最大,它使 100 %的长兴期种灭绝;卡尼期末的灭绝事件规模也较大,它使 97.7 %的卡尼期种灭绝。

关键词　房室海绵　演化　灭绝　生物礁　二叠纪

许多学者已经研究了主要浅海底栖非礁相无脊椎动物在二叠-三叠纪的演化(杨遵仪等,1991),但对礁相生物在该时期的演化尚无专门的研究。

二叠纪的造礁生物主要是钙质海绵。钙质海绵指分泌钙质骨骼的海绵,主要包括纤维海绵、房室海绵、硬海绵。有的学者称古生代的房室海绵 *Girtyocoelia* 延续到了三叠纪(Flügel and Stanley, 1984),但后来他们放弃了这种看法,认为是异物同名(Flügel, 1994)。因此,开展详细的研究来进一步检查礁相生物在二叠纪-三叠纪的演化显得十分需要。

研究礁相生物演化最好在种的水平上进行,物种才是生物存在的基本单元,而属是种的归并。由于属的内涵更广,属的鉴定有更大的人为性,所以,一个种从这个属移到另一个属的情形很常见。为了使演化的研究更可靠,二叠纪-三叠纪礁相生物演化的研究应该在种的水平上做,而不是在属的水平上做。

本文试图在种的水平上探讨二叠纪 - 三叠纪造礁房室海绵的演化。由于不同学者的化石鉴定有所差异,所以,在任何的物种统计工作中不能直接使用现成的古生物鉴定资料,而要根据同一标准对它们进行重新审定,用同一标准审定过的古生物资料才可用于统计。

本文的统计是建立在对所有资料进行同一标准审定的基础上,凡有图版或插图的二叠纪-三叠纪礁相房室海绵都予以采用,没有图版的化石由于不能进行核查,所以暂未采用。涉及的文献最早的是 Waagen 和 Wentzel (1887),最晚的是 Rigby 等(1998)对瓜达卢佩礁房室海绵的描述。所有的房室海绵化石的图版都与其模式种的图版进行对比,对鉴定错误的给予更正。

长兴期生物礁主要分布在中国。所以,对中国的长兴期生物礁的房室海绵化石的全面描述是本次统计研究的基础。过去的描述工作都只涉及较大化石(直径大于 0.5 cm),而忽视了小型房室海绵化石。本文对贵州紫云的长兴期生物礁中的小型房室海绵化石也予以统计。

1　二叠纪-三叠纪的礁相房室海绵

1.1　早二叠世礁的房室海绵

早二叠世礁相房室海绵主要发现于意大利的西西里(Aleotti *et al.*, 1986),我们核查后认定有如下种(属种名称之后括号中的字母是该属种的产地缩写;S:意大利西西里):

Amblysiphonella barroisi Steinmann (S)

Colospongia cf. *benjamini* (Girty) (S)

Discosiphonella lercarensis Senowbari-Daryan *et*

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Di Stefano (S)

Girtyocoelia beedei (Girty) (S)

Guadalupia cylindrica Girty (S)

Parauvanella paronai Senowbari-Daryan *et* Di Stefano (S)

Salzburgia sp. (S)

Sollasia ostiolata Steinmann (S)

Sollasia sp. (S)

1.2 中二叠世的礁相房室海绵

中二叠世的礁相房室海绵主要产自巴基斯坦的盐岭(Waagen and Wentzel, 1887),意大利的西西里(Aleotti *et al*., 1986),突尼斯的塞巴加(Senowbari-Daryan and Rigby, 1988),我国广西隆林(范嘉松等,1990; Wu, 1991)和贵州紫云,阿曼山脉(Weidlich and Senowbari-Daryan, 1996)。我们核查后,确认有如下 111 种(属种后面括号内字母表示该属种产地缩写,S:意大利西西里,R:巴基斯坦盐岭,T:突尼斯塞巴加,X:广西隆林祥播,Z:贵州紫云,O:安曼):

Amblysiphonella ? permosicula (Parona) (S)

Amblysiphonella bancaoensis Zhang (O)

Amblysiphonella cf. *A. merlai* Parona (T)

Amblysiphonella cf. *merlai* Parona (G)

Amblysiphonella clathrata Parona (S)

Amblysiphonella merlai Parona (O, S, T)

Amblysiphonella multilamellosa Waagen *et* Wentzel (R)

Amblysiphonella nodulifera Girty (S)

Amblysiphonella obliqua Senowbari-Daryan *et* Rigby (T)

Amblysiphonella omanica Weidlich *et* Senowbari-Daryan (O)

Amblysiphonella ramosa Senowbari-Daryan *et* Rigby (T)

Amblysiphonella socialis Waagen *et* Wentzel (O, R)

Amblysiphonella sp. (O)

Amblysiphonella sp. (X)

Amblysiphonella sp. A (G)

Amblysiphonella sp. B (G)

Amblysiphonella vesiculosa (Koninck) (R, S)

Amblysiph. spinosa Rigby, Fan *et* Zhang (X)

Amphorithalamia cateniformis Senowbari-Daryan *et* Rigby (T)

Bullicoelia columnaria (Weidlich *et* Senowbari-Daryan) (O)

Carterina gracilis Rigby, Fan *et* Zhang (T)

Carterina pyramidata Waagen *et* Wentzel (R)

Colospongia cf. *americana* (Girty) (O)

Colospongia cortexifera Senowbari-Daryan *et* Rigby (O, S, T)

Colos. gemina (Waagen *et* Wentzel) (R, S)

Colospongia sinensis Wu (Z)

Colospongia maxima Rigby, Fan *et* Zhang (O)

Colos. paronae Aleotti, Dieci *et* Russo (S)

Colos. salinaria (Waagen *et* Wentzel) (R)

Colospongia sp. (X)

Cystospongia guangxiensis Wu (X)

Cystothalamia adrianensis Senowbari-Daryan (S)

Cystothalamia conica (Termier *et* Termier) (T)

Cystothalamia distefanoi Senowbari-Daryan (S)

Cystothalamia guadalupensis (Girty) (G)

Cystothalamia nodulifera Girty (S)

Discosiphonella (= Cystauletes) lercarensis Senowbari-Daryan *et* Di Stefano (T)

Discosiphonella (= Cystauletes) mammilosa (King) (T, G)

Discosiphonella (= Cystauletes) sp. (X)

Discosiphonella radicifera (Waagen *et* Wentzel) (R)

Enoplocoelia interchora Senowbari-Daryan *et* Rigby (T)

Exaulipora permica (Senowbari-Daryan) (G)

Follicatena sp. (X)

Girtyocoelia beedei (Girty) (T, O, G)

Girtyocoelia gracilis Weidlich *et* Senowbari-Daryan (O)

Graminospongia girtyi (Parona) (T, S)

Guadalupia ? cidarites Parona (S)

Guadalupia cidarites Parona (S)

Guadalupia cylindrica Girty (S, T)

Guadalupia digitata (Girty) (G)

Guadalupia minima Parona (S) (X)

Guangxispongia spinalis Wu (X, Z)

Huibaoia exaulifera Rigby, Senowbari-Daryan *et* Liu (G)

Imbricatocoelia elongata Rigby, Fan *et* Zhang (O, X, S, T)
Imbricatocoelia ramosa Senowbari-Daryan *et* Rigby (X)
Imbricatocoelia sp. (Parona) (S)
Imbricat. irregulara Rigby, Fan *et* Zhang (X)
Imbricat. obconica Rigby, Fan *et* Zhang (X)
Imbricat. paucipora Rigby, Fan *et* Zhang (X)
Imperatoria (?) sp. (Z)
Intrasporeocoelia laxa Wu (X)
Intr. hubeiensis Fan *et* Zhang (S, O, X, T)
Laccosiphonella merlai (Parona) (S)
Lemonea ? polysiphonata Senowbari-Daryan (Wu) (G)
Lemonea conica Senowbari-Daryan (G)
Pachyphleia typica Wu (Z)
Parauvanella sp. (X)
Parauvanella cylindrica Wu (Z)
Par. minima Senowbari-Daryan (O, X, G)
Parauvanella paronai Senowbari-Daryan *et* Di Stefano (O, T)
Pisothalamia spiculata Senowbari-Daryan *et* Rigby (T)
Planiguadalupia explanata (King) (G)
Platythalamiella ? sp. (G)
Platythalamiella newelli Senowbari-Daryan *et* Rigby (T)
Polycystocoelia cf. *huajiaopingensis* Zhang (T)
Polycystothalamia sinuolata Wu (X)
Polycystothalamia sp. (X)
Polyedra tebagaensis Senowbari-Daryan *et* Rigby (T)
Polyphymaspongia zitteliana (Girty) (G)
Preverticillites columnella Parona (O, S, T)
Preverticillites parva Rigby, Senowbari-Daryan *et* Liu (G)
Pseudoamblysiphonella polysiphonata Senowbari-Daryan *et* Rigby (T)
Pseudoguadalupia alveolaris (Parona) (S, T)
Rahbahthalamia bullifera (Senowbari-Daryan *et* Rigby) (O, T)
Reticulospongia reticulata Wu (Z, X)
Rhabdactinia depressa Rigby, Fan *et* Zhang (X, T)
Rhab. squamata Rigby, Fan *et* Zhang (X)
Salzburgia ? irregularis Weidlich *et* Senowbari-Daryan (O)
Salzburgia ? nana Rigby, Fan *et* Zhang (X)
Solenolmia (= Dictyocoelia) permica Senowbari-Daryan *et* Rigby (T, S)
Solidothalamia cylindrica (Girty) (G)
Solidothalamia lambdiformis Wu (X)
Solidothalamia ? micra (Rigby, Senowbari-Daryan *et* Liu) (G)
Sollasia abista Rigby, Fan *et* Zhang (O, X)
Sollasia ostiolata permica Parona (S)
Sollasia ostiolata Steinmann (S, O, T, X, G)
Sollasia spheroida Rigby, Fan *et* Zhang (O, X)
Spica spica Termier *et* Termier (O, T)
Stromatogloma typica Wu (X)
Stylocoelia circopora Wu (Z, S, X)
Stylothalamia elegant Rigby, Fan, Wang *et* Zhang (Z)
Subascosymplegma oussifensis (Termier *et* Termier) (T)
Tebagathalamia cylindrica Senowbari-Daryan *et* Rigby (T, X)
Tebagathalamia diagonalis Wu (X)
Tebagathalamia granularis Wu (X)
Tebagathalamia lamella Wu (X, Z)
Thaumastocoelia ? irregularis Weidlich *et* Senowbari-Daryan (O)
Thaumastocoelia sp. (O)
Tristratocoelia rhythmica Senowbari-Daryan *et* Rigby (T, G)
Uvothalamia planiinvoluta Senowbari-Daryan (S)
Welteria ? hawasinensis Weidlich *et* Senowbari-Daryan (O)

1.3　晚二叠世长兴期的礁相房室海绵

晚二叠世吴家坪期生物礁中的房室海绵缺乏资料,长兴期生物礁的房室海绵主要产自湖北利川(Fan and Zhang, 1985),四川重庆北培和涧水沟(Fan *et al.*, 1989),泰国(Senowbari-Daryan and Ingavat-Helmcke, 1994),广西隆林(范嘉松等,1990),贵州紫云。我们核查后,确认 84 种(属种后面字母是该属种产地的缩写,L:湖北利川,LA:重庆北培老龙洞,Th:泰国,X:广西隆林祥播,J:重庆华蓥涧水

沟,Z:贵州紫云):

Ambithalamia permica Senowbari-Daryan *et* Ingavat-Helmcke (Th)
Amblysiphonella bancaoensis Zhang (L)
Amblysiphonella merlai ? Parona (X)
Amblysiphonella obliquisepta Zhang (L)
Amblysiphonella omanica Weidlich *et* Senowbari-Daryan (Z)
Amblysiphonella regularis Zhang (L)
Amblysiphonella sp. A (X)
Amblysiphonella sp. B (X)
Amblysiphonella specialis Rigby, Fan *et* Zhang (LA)
Amblysiphonella vesiculosa minima Zhang (L)
Amblysiphonella yini Fan *et* Zhang (L)
Baryspongia beedei Wu (Z)
Belyaevaspongia insolita (Belyaeva) (Th)
Carterina gracilis Rigby, Fan *et* Zhang (J, Z, LA)
Carterina pyramidata Waagen *et* Wentzel (LA)
Colospongia cf. *dubia* Laube (L)
Colospongia cortexifera Senowbari-Daryan *et* Rigby Wu (J, Z)
Colosp. gemina (Waagen *et* Wentzel)) (Z, L)
Colospongia maxima Rigby, Fan *et* Zhang (X)
Colospongia sp. (Th)
Colospongia sp. (Z)
Colospongia spheroida Wu (Z)
Colospongia tubiformis Wu (Z)
Diecithalamia permica Wu (Z)
Discosiphonella asiatica (Fan *et* Zhang) (L, X)
Discosiphonella heteroideus Wu (Z)
Discosiphonella lepida (Zhang) (L)
Discosiphonella orientalis (Fan *et* Zhang) (L)
Discosiphonella ostiolata Wu (Z)
Discosiphonella spongioformis Wu (Z)
Discosiphonella typica (Zhang) (L, X)
Discosiphonella variabilis (Zhang) (L)
Drupinella irregularis Wu (Z)
? *Girtyocoelia beedei* (Girty) Wu (Th)
Girtyocoelia fibrilata Wu (Z)
Girtyocoelia sp. (L)
Guadalupia cylindrica Girty (Z)
Guadalupia irregularis Wu (Z)
Guadalupia minima Parona (Z)
Huayingia glomerata Rigby, Fan, Wang *et* Zhang (J)
Imbricatocoelia elongata Rigby, Fan *et* Zhang (X)
Intrasporeocoelia hubeiensis Fan *et* Zhang (Z, L, Th)
Monocoelia flata Wu (Z)
Neoguadalupia explanata Rigby, Fan *et* Zhang (X)
Pachycoelia siphonella Wu (Z)
Parauvanella cylindrica Wu (Z)
Parauvanella irregulara Wu (Z)
Parauvanella maxima Wu (Z)
Parauvanella minima (Senowbari-Daryan) Wu (LA)
Parauvanella minima (Senowbari-Daryan) (L)
Parauvanella paronai Senowbari-Daryan *et* Di Stefano (?, Wu) (J, Z)
Parauvanella sp. (L)
Parauvanella spinosa Wu (Z)
Phraethalamia tubulara Senowbari-Daryan *et* Ingavat-Helmcke (Th)
Pinacophyllum orthocera Wu (Z)
Pinacophyllum parallela Wu (Z)
Polycystocoelia asiatica (Fan *et* Zhang) (L, X)
Polycystocoelia huajiaopingensis Zhang (X, Z, J)
Polycystocoelia sinica Zhang (L)
Polycystocoelia sp. (Z)
Polytholosia tubifera Wu (Z)
Preverticillites columnella (Parona) Wu (X)
Pseudodeningeria pachyphloeus Wu (Z)
Rahbahthalamia bullifera (Senowbari-Daryan *et* Rigby) (Z)
Rhabdactinia columnaria Yabe *et* Sugiyama (X, Z)
Rhabdac. irregulara Rigby, Fan *et* Zhang (Z)
Rhabdactinia regulara Wu (Z)
Salzburgia irregulara Wu (Z)
Salzburgia permica Wu (Z)
Solenolmia ? sp. (Z)
Sollasia angulara Wu (Z)
Sollasia irregulara Wu (Z)

Sollasia minima Wu (Z)
Sollasia ostiolata Steinmann (J ,Z ,Th)
Sollasia sp. (L)
Sollasia spheroida ? Rigby , Fan *et* Zhang (Th)
Sollasia tubiformis Wu (Z)
Spinocoelia spinosa Wu (Z)
Stromatogloma typica Wu (Z)
Subascosymplegma ? *paracatenulata* Rigby , Fan *et* Zhang (X)
Subascosymplegma sp. (Z)
Tebagathalamia minima Wu (Z)
Tristratocoelia rhythmica Senowbari-Daryan *et* Rigby (Th)
Uvanella micritica Wu (Z)

1.4　中三叠世安尼期 - 拉丁尼期的礁相房室海绵

中三叠世的礁相房室海绵主要产自北阿尔卑斯(Fois and Gaetani , 1984)、意大利(Senowbari-Daryan *et al*. , 1993; Gaetani *et al*. , 1981)、匈牙利。我们核查后认定 22 种(属种名之后括号内字母是该属种产地缩写 ,A :北阿尔卑斯 ,D :西 Dolomite , ID :意大利 Dolomites , H :匈牙利) :

Alpinothalamia bavarica (Ott) (A)
Anisothalamia minima Senowbari-Daryan *et al*. (ID)
Celyphia ? *minima* Senowbari-Daryan *et al*. (ID)
Celyphia zoldana Ott , Pisa *et* Farabegoli (ID)
Colospongia catenulata (D)
Colospongia catenulata catenulata Ott (A)
Colosp. catenulata macrocatenulata Scholz (H)
Colospongia sp. (ID)
Cryptocoelia manon manon (Munster) (A)
Cryptocoelia zitteli Steinmann(D)
Deningeria crassireticulata Senowbari-Daryan *et al*. (ID)
Deningeria tenuireticulata Senowbari-Daryan *et al*. (ID)
Diecithalamia polysiphonata Dieci , Antonacci *et* Zardini (A)
Follicatena cautica Ott (A ,D)
Girtyocoelia oenipontana Ott (D)
Olangocoelia otti Bechstadt *et* Brandner (ID)
Sestrocatena alpinus (Ott) (D ,A)
Solenolmia (= Dictyocoelia) manon (D)
Thaumastocoelia ? *dolomitica* Senowbari-Daryan *et al*. (Wu) (ID)
Uvanella irregularis Ott (D ,A)
Uvanella norica Senowbari-Daryan (ID)
Vesicocaulis depressus Ott (A ,D)

1.5　晚三叠世卡尼期的礁相房室海绵

晚三叠世卡尼期的礁相房室海绵主要产自意大利(Fürsich and Wendt , 1977) ;安曼(Weidlich and Senowbari-Daryan , 1996)。根据核查 ,我们认定 44 种(属种名称之后括号内字母是该属种产地缩写 , G: Greek island , O :安曼 ,C :Civetta , D :Dolomites) :

Amblysiphonella cf. *A. lorentheyi* Vinassa De Regny (G)
Amblysiphonella lorentheyi Vinassa (D)
Amblysiphonella minima Senowbari-Daryan *et* Shafer (G)
Amblysiphonella strobiliformis Dieci , Antonacci *et* Zardini (D)
Amblysiphonella timorca Vinassa (D)
Aplinothalamia bavarica Ott (D)
Aplinothal. slovenica (Senowbari-Daryan) (O)
Ascosymplegma expansum Seilacher (D)
Celyphia submarginata (Munster) (D)
Ceotinella mirunae Pantic (G ,O)
Colospongia andrusovi Jablonsky (G)
Colospongia catenulata catenulata Ott (G)
Colospongia cf. *C. elongata* (Wilckens) (G)
Colospongia dubia (Munster) (D ,G)
Colospongia sp. 1 (G)
Colospongia sp. 2 (G)
Cryptocoelia lata Senowbari-Daryan *et al*. (G)
Cryptocoelia zitteli Steinmann (D ,G ,O)
Enoplocoelia armata (Klipstein) (D)
Follicatena cautica Ott (G)
Girtyocoelia ostiaesaccus Senowbari-Daryan (G)
Prosiphonella amplectens Dieci , Antonacci *et* Zardini (D)
Sestrocatena alpinus Ott (G)
Solenolmia (= Dictyocoelia) manon (Munster) (G ,D)
Solenolmia (= Dictyocoelia) manon manon (Munster) (C ,O)
? *Solenolmia (= Dictyocoelia) manon* (Munster) (G)

Stylothalamia dehmi Ott (G)
Thaumastocoelia cassiana Steinmann (D)
Uvanella ? lamellata Senowbari-Daryan (O)
Uvanella irregularis Ott (C, G)
Verticillites ? sp. 1 (G)
Verticillites cf. *cretaceus* Defrance (G)
Vesicocaulis carinthiacus Ott (G)
Vesicocaulis depress Ott (D)
Vesicocaulis multisiphonatus Kovacs (G)
Vesicocaulis polysiphonata Dieci, Antonacci *et* Zardini (D)
Vesicocaulis reticuliformis Jablonsky (G)
Zardinia ? sp. 2 (G)
Zardinia cf. *perisulcata* Dieci *et al*. (G)
Zardinia cf. *platithalamica* Dieci *et al*. (G)
Zardinia perisulcata Dieci, Antonacci *et* Zardini (D)
Zardinia platithalamica Dieci, Antonacci *et* Zardini (D)
Zardinia cylindrica Senowbari-Daryan *et* Shafer (G)
Zardinia sp. 1 (G)

1.6 晚三叠世诺利期 - 瑞替期的礁相房室海绵

晚三叠世诺利期—瑞替期的礁相房室海绵主要产自意大利的西西里(Di Stefano, *et al*., 1990)、北阿尔卑山(Senowbari-Daryan and Schafer, 1979)、美国内华达(Senowbari-Daryan and Stanley, 1992)、加拿大育空(Senowbari-Daryan and Reid, 1987)、希腊(Senowbari-Daryan *et al*., 1996)。根据我们的核查,确认 63 种(属种名称之后括号内字母是该属种产地缩写,S:意大利西西里,A:Northern Calcareous Alps, N:美国内华达,T:土耳其,Y:加拿大育空,G:希腊):

? Cryptocoelia zitteli Steinmann (Y)
Alpinothalamia minima (Senowbari-Daryan *et* Schafer) (S)
Amblysiphonella ? polyformis Senowbari-Daryan *et* Schafer (S)
Amblysiphonella sp. 1 (S)
Amblysiphonella sp. 2 (S)
Amblysiphonella sp. 3 (S)
Annaecoelia interiecta Senowbari-Daryan *et* Schafer (A)
Annaecoelia mirabilis Senowbari-Daryan *et* Schafer (A)
Antalythalamia riedeli Senowbari-Daryan (T)
Ascosymplegma expansum Seilacher (Y)
Battaglia major Senowbari-Daryan *et al*. (S)
Battaglia minor Senowbari-Daryan *et al*. (S)
Celyphia ? norica Senowbari-Daryan *et al*. (S)
Cheilosporites tirolensis Wahner (S, G)
Cinnabaria expansa (Seilacher) (N)
Cinnabaria minima Senowbari-Daryan (G)
Colospongia bimuralis Senowbari-Daryan (Y)
Colospongia cf. *menulensis* Senowbari-Daryan *et* Schafer (Y)
Colospongia dubia ? (Munster) Wu (Y)
Colospongia mennulensis Senowbari-Daryan *et* Schafer (S)
Cribrothalamia madoniensis Senowbari-Daryan (S)
Cryptocoelia crassiparietalis Senowbari-Daryan *et* Schafer (S)
Cryptocoelia lupensis Senowbari-Daryan (S)
Cryptoc. tenuiparietalis Senowbari-Daryan (S)
Discosiphonella ? sp. (S)
Follicatena irregularis Senowbari-Daryan *et* Schafer (S, Y)
Gigantothalamia ovoidalis Senowbari-Daryan (T)
Henricellum cf. *insigne* Wilckens (Y)
Madonia conica Senowbari-Daryan *et al*. (S)
Neoguadalupia ? norica Senowbari-Darytan *et* Stanley (N)
Nevadathalamia cylindrica (Seilacher) (N)
Panormida priscae Senowbari-Daryan (S)
Paradeningeria alpina Senowbari-Daryan *et* Schafer (A, Y)
Paradeningeria gruberensis Senowbari-Daryan *et* Schafer (A)
Paradeningeria sp. (S)
Paradeningeria weyli Senowbari-Daryan *et* Schafer (A)
Paravesicocaulis multiosculatus Kovacs (S)
Platythalamiella siciliana Senowbari-Daryan (S)
Polycystocoelia norica Senowbari-Daryan *et* Reid (Y)

Polycystocoelia sp. 1 (Y)
Polysiphospongia collesanensis Senowbari-Daryan *et* Schafer (S)
Polysiphospongia fluegeli Senowbari-Daryan *et* Schafer (S)
Polytholosia sp. 1 (S)
Polytholosia sp. 2 (S)
Polytholosia sp. 3 (S)
Pseudouvanella parallela Senowbari-Daryan (T)
Salzburgia ? sp. (Y)
Salzburgia variabilis Senowbari-Daryan *et* Schafer (A)
Solenolmia (= *Dictyocoelia*) ? sp. (S)
Solenolmia cf. *manon* (Munste) (Y)
Sollasia ? aff. *baloghi* Kovacs (S)
Sphaerothalamia vesiculifera Senowbari-Daryan (T)
Stylothalamia polysiphonata Senowbari-Daryan (T)
Thaumastocoelia ovoidalis Senowbari-Daryan (T)
Thaumastocoelia ? sphaeroida Senowbari-Daryan (Wu) (T)
Uvanella ? irregularis Ott (Y)
Uvanella ? tegimentopora Senowbari-Daryan *et* Schafer (S)
Uvanella cf. *irregularis* Ott (S)
Verticillites conicus Senowbari-Daryan *et* Schafer (S)
Weidlichia cylindrica (Senowbari-Daryan) (S)
Weidlichia siciliana (Senowbari-Daryan) (S)
Welteria ? sp. (S)
Yukonella rigbyi Senowbari-Daryan *et al*. (Y)

2　不同时期礁相房室海绵的比较

表 I列出二叠纪-三叠纪各个时期礁相房室海绵化石的物种数,以及每个时期由前一时期延续来的物种数。由表 I可见,早二叠世礁相房室海绵物种数最少,中二叠世礁相房室海绵物种分异度最高,晚二叠世礁相房室海绵物种数其次,中三叠世礁相房室海绵较少,卡尼期礁相房室海绵物种数增多,诺利期-瑞替期礁相房室海绵更多。

表 I　二叠纪-三叠纪各时期礁相房室海绵物种数

Reefal thalamid sponge species of Permian-Triassic periods

时期	早二叠世	中二叠世	晚二叠世	中三叠世	卡尼期	诺利期
总种数	9	111	84	22	44	63
从前期延续来的种		5	18	0	7	1

通过比较可见,早二叠世的房室海绵物种有 55.6 %延续到中二叠世。中二叠世的礁相房室海绵物种有 16.2 %延续到晚二叠世。晚二叠世的礁相房室海绵没有一个种能够延续到三叠纪。中三叠世的礁相房室海绵有 31.8 %延续到晚三叠世卡尼期。卡尼期的礁相房室海绵有 2.3 %延续到晚三叠世诺利期-瑞替期。插图 1 是二叠纪-三叠纪各个时期的礁相房室海绵种中能够延续到下一时期者的百分数。

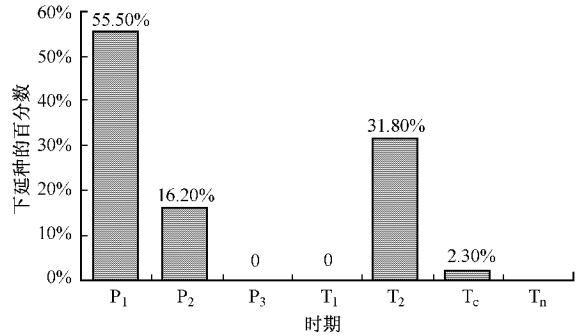

插图 1　二叠纪 - 三叠纪各个时期延续种的百分数

Reefal thalamid sponge species lasting to late period

P_1 = 早二叠世; P_2 = 中二叠世; P_3 = 长兴期; T_1 = 早三叠世; T_2 = 安尼期—拉丁尼期; Tc = 卡尼期; Tn = 诺利期—瑞替期

由插图 1 可见,中二叠世的礁相房室海绵大多数灭绝了,只有 16.2 %的种能够延续到晚二叠世。晚二叠世的礁相房室海绵全部灭绝了,没有一个种能够延续到早三叠世。卡尼期的礁相房室海绵也几乎全部灭绝了。

Flügel 和 Stanley (1984) 认为二叠纪的房室海绵 *Grityocoelia* 延续到三叠纪。但后来 Flügel (1994) 纠正了这一看法。他认为三叠纪的 *Girtyocoelia* 与二叠纪的是异物同名,并且认为三叠纪的 *Amblysiphonella*, *Colospongia* 只是与二叠纪的形态相似,不是从二叠纪延续来的。

礁相房室海绵的演化反映出二叠纪 - 三叠纪有 3 次灭绝事件,它们发生在中二叠世末期、长兴期末期、卡尼期末期。这 3 次灭绝事件不仅在礁相房室海绵,而且在其它的生物门类中也有反映 (Erwin,

1993; Hallam and Wignall, 1997; Jin, Y. and Chi-Ming-Ssu, 1994; Stanley, 1988; 杨遵仪等, 1991)。这 3 次灭绝事件的规模各不相同:长兴期末期的规模最大,它使 100 %的长兴期礁相房室海绵灭绝;中二叠世末期的灭绝事件规模较小,它使 83.8 %的礁相房室海绵灭绝;卡尼期末期的灭绝事件规模也较大,它使 97.7 %的卡尼期礁相房室海绵灭绝。

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PERMIAN-TRIASSIC HISTORY OF REEFAL THALAMID SPONGES: EVOLUTION AND EXTINCTION

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Key words thalamid sponges, extinction, Permian, Triassic

All described Permian-Triassic reefal thalamid sponges are checked under the same taxonomic standard of species and those incorrectly assigned are placed respectively in the right taxon. Then the thalamid sponges of different Permian-Triassic periods are compared at specific level in this study.

The division of Permian System by Jin *et al*. (1997) (Table 1) and that of Triassic System by Harland *et al*. (1989) (Table 2) are followed.

All described thalamid sponges from Permian and Triassic reefs are included in the study, except for those without pictures, which makes it impossible for us to check their identification. Pictures of all described thalamid sponges used in the study have been compared to the picture of the monotype of a given species and those inappropriately identified by previous researchers were assigned to the right taxon.

In previous studies medium size (diameter > 0.5 cm) and large size (diameter > 1 cm) thalamid sponges caught more attention. On the contrary, small thalamid sponges were mostly overlooked. In this study small thalamid sponges in the Changhsingian reefs of Ziyun, Guizhou Province, China are also included.

1 Thalamid sponges in Early Permian reefs

According to our examination, the following 9 thalamid sponge species from Early Permian reefs have been confirmed(The letter in "()" indicates the occurrence locality. S: Sicily, Italy):

Amblysiphonella barroisi Steinmann (S)

Colospongia cf. *benjamini* (Girty) (S)

Discosiphonella lercarensis Senowbari-Daryan et Di Stefano (S)

Girtyocoelia beedei (Girty) (S)

Guadalupia cylindrica Girty (S)

Table 1　Division scheme of Permian System (Jin et al**., 1997)**

	Series	Stages	Fusulinid Zones
Triassic		Griesbachian	
Permian	Upper Permian	Changhsingian	*Palaeofusulina sinensis*
		Wuchiapingian	*Nanlingella simplex* *Codonofusiella kwangsiana*
	Middle Permian	Capitanian	*Lepidolina* *Yabeina* *Polydiexodina shumardi*
		Wordian	*Neoschwagerina craticalifera*
		Roadian	*Praesumatrina neoschwagerina* *Cancellina cutalensis-Armerina*
		Kungurian	*Misellina claudiae* *Brevaxina dyhrenfurthi*
	Lower Permian	Artinskian	*Pamirina* *Charaloschwagerina vulgaris*
		Sakmarian	*Robustoschwagerina schellwieni* *Sphaeroschwagerina sphaerica*
		Asselian	*Sphaeroschwagerina moelleri* *Sphaeroschwagerina vulgaris*
Carboniferous		Gzhelian	*Daixina robusta-Daixina bosbytauensis* *Triticites stuckenbergi*

Parauvanella paronai Senowbari-Daryan et Di Stefano (S)
Salzburgia sp. (S)
Sollasia ostiolata Steinmann (S)
Sollasia sp. (S)

Table 2 Division of Triassic (Harland et al., 1989)

	Series	Stages
Jurassic		
Triassic	Upper Triassic	Rhaetian
		Norian
		Carnian
	Middle Triassic	Ladinian
		Anisian
	Lower Triassic	Spathian
		Nammalian
		Griesbachian
Permian		

2 Thalamid spongs in Middle Permian Guadalupian reefs

According to our examination, the following 111 thalamid species from Middle Permian reefs are confirmed (The letter in "()" indicates the occurrence locality. R: Salt Range, Pakistan; S: Sicily, Italy; T: Tebaga, Tunisia; X: Xiangbo, Guangxi Province, China; Z: Ziyun, Guizhou Province, China; O: Oman Mountains):

Amblysiphonella ? permosicula (Parona) (S)
Amblysiphonella bancaoensis Zhang (O)
Amblysiphonella cf. *merlai* Parona (T)
Amblysiphonella cf. *merlai* Parona (G)
Amblysiphonella clathrata Parona (S)
Amblysiphonella merlai Parona (O, S, T)
Amblysiphonella multilamellosa Waagen *et* Wentzel (R)
Amblysiphonella nodulifera Girty (S)
Amblysiphonella obliqua Senowbari-Daryan *et* Rigby (T)
Amblysiphonella omanica Weidlich *et* Senowbari-Daryan (O)
Amblysiphonella ramosa Senowbari-Daryan *et* Rigby (T)
Amblysiphonella socialis Waagen *et* Wentzel (O, R)
Amblysiphonella sp. (O)
Amblysiphonella sp. (X)
Amblysiphonella sp. A (G)
Amblysiphonella sp. B (G)
Amblysiph. spinosa Rigby, Fan *et* Zhang (X)
Amblysiphonella vesiculosa (Koninck) (R, S)
Amphorithalamia cateniformis Senowbari-Daryan *et* Rigby (T)
Bullicoelia columnaria (Weidlich *et* Senowbari-Daryan) (O)
Carterina gracilis Rigby, Fan *et* Zhang (T)
Carterina pyramidata Waagen *et* Wentzel (R)
Colospongia cf. *americana* (Girty) (O)
Colospongia cortexifera Senowbari-Daryan *et* Rigby (O, S, T)
Colos. gemina (Waagen *et* Wentzel) (R, S)
Colospongia sinensis Wu (Z)
Colospongia maxima Rigby, Fan *et* Zhang (O)
Colos. paronae Aleotti, Dieci *et* Russo (S)
Colos. salinaria (Waagen *et* Wentzel) (R)
Colospongia sp. (X)
Cystospongia guangxiensis Wu (X)
Cystothalamia adrianensis Senowbari-Daryan (S)
Cystothalamia conica (Termier *et* Termier) (T)
Cystothalamia distefanoi Senowbari-Daryan (S)
Cystothalamia guadalupensis (Girty) (G)
Cystothalamia nodulifera Girty (S)
Discosiphonella (= Cystauletes) lercarensis Senowbari-Daryan *et* Di Stefano (T)
Discosiphonella (= Cystauletes) mammilosa (King) (T, G)
Discosiphonella (= Cystauletes) sp. (X)
Discosiphonella radicifera (Waagen *et* Wentzel) (R)
Enoplocoelia interchora Senowbari-Daryan *et* Rigby (T)
Exaulipora permica (Senowbari-Daryan) (G)
Follicatena sp. (X)
Girtyocoelia beedei (Girty) (T, O, G)
Girtyocoelia gracilis Weidlich *et* Senowbari-Daryan (O)
Graminospongia girtyi (Parona) (T, S)
Guadalupia ? cidarites Parona (S)
Guadalupia cidarites Parona (S)
Guadalupia cylindrica Girty (S, T)
Guadalupia digitata (Girty) (G)
Guadalupia minima Parona (S, X)
Guangxispongia spinalis Wu (X, Z)
Huibaoia exaulifera Rigby, Senowbari-Daryan

et Liu (G)

Imbricatocoelia ramosa Senowbari-Daryan *et* Rigby (X)

Imbricatocoelia sp. (Parona) (S)

Imbricatocoelia elongata Rigby, Fan *et* Zhang (O, X, S, T)

Imbricat. irregulara Rigby, Fan *et* Zhang (X)

Imbricat. obconica Rigby, Fan *et* Zhang (X)

Imbricat. paucipora Rigby, Fan *et* Zhang (X)

Imperatoria ? sp. (Z)

Intrasporeocoelia laxa Wu (X)

Intr. hubeiensis Fan *et* Zhang (S, O, X, T)

Laccosiphonella merlai (Parona) (S)

Lemonea ? *polysiphonata* Senowbari-Daryan Wu (G)

Lemonea conica Senowbari-Daryan (G)

Pachyphleia typica Wu (Z)

Parauvanella sp. (X)

Parauvanella cylindrica Wu (Z)

Par. minima Senowbari-Daryan (O, X, G)

Parauvanella paronai Senowbari-Daryan *et* Di Stefano (O, T)

Pisothalamia spiculata Senowbari-Daryan *et* Rigby (T)

Planiguadalupia explanata (King) (G)

Platythalamiella ? sp. (G)

Platythalamiella newelli Senowbari-Daryan *et* Rigby (T)

Polycystocoelia cf. *huajiaopingensis* Zhang (T)

Polycystothalamia sinuolata Wu (X)

Polycystothalamia sp. (X)

Polyedra tebagaensis Senowbari-Daryan *et* Rigby (T)

Polyphymaspongia zitteliana (Girty) (G)

Preverticillites columnella Parona (O, S, T)

Preverticillites parva Rigby, Senowbari-Daryan *et* Liu (G)

Pseudoamblysiphonella polysiphonata Senowbari-Daryan *et* Rigby (T)

Pseudoguadalupia alveolaris (Parona) (S, T)

Rahbahthalamia bullifera (Senowbari-Daryan *et* Rigby) (O, T)

Reticulospongia reticulata Wu (Z, X)

Rhabdactinia depressa Rigby, Fan *et* Zhang (X, T)

Rhab. squamata Rigby, Fan *et* Zhang (X)

Salzburgia ? *irregularis* Weidlich *et* Senowbari-Daryan (O)

Salzburgia ? *nana* Rigby, Fan *et* Zhang (X)

Solenolmia (= *Dictyocoelia*) *permica* Senowbari-Daryan *et* Rigby (T, S)

Solidothalamia cylindrica (Girty) (G)

Solidothalamia lambdiformis Wu (X)

Solidothalamia ? *micra* (Rigby, Senowbari-Daryan *et* Liu) (G)

Sollasia abista Rigby, Fan *et* Zhang (O, X)

Sollasia ostiolata permica Parona (S)

Sollasia ostiolata Steinmann (S, O, T, X, G)

Sollasia spheroida Rigby, Fan *et* Zhang (O, X)

Spica spica Termier *et* Termier (O, T)

Stromatogloma typica Wu (X)

Stylocoelia circopora Wu (Z, S, X)

Stylothalamia elegant Rigby, Fan, Wang *et* Zhang (Z)

Subascosymplegma oussifensis (Termier *et* Termier) (T)

Tebagathalamia cylindrica Senowbari-Daryan *et* Rigby (T, X)

Tebagathalamia diagonalis Wu (X)

Tebagathalamia granularis Wu (X)

Tebagathalamia lamella Wu (X, Z)

Thaumastocoelia ? *irregularis* Weidlich *et* Senowbari-Daryan (O)

Thaumastocoelia sp. (O)

Tristratocoelia rhythmica Senowbari-Daryan *et* Rigby (T, G)

Uvothalamia planiinvoluta Senowbari-Daryan (S)

Welteria ? *hawasinensis* Weidlich *et* Senowbari-Daryan (O)

3　Thalamid sponges in Upper Permian Changhsingian reefs

According to our examination, the following thalamid species from the Upper Permian Changhsingian have been confirmed (The letter in "()" indicates the occurrence locality. L: Lichuan, Hubei Province, China; LA: Laolongdong, Beipei, Sichuan Province, China; Th: Thailand; X: Xiangbo, Guangxi Province, China; J: Jianshuigou, Sichuan Province, China; Z: Ziyun, Guizhou Province, China).

Ambithalamia permica Senowbari-Daryan and Ingavat-Helmcke (Th)

Amblysiphonella bancaoensis Zhang (L)

Amblysiphonella merlai ? Parona (X)

Amblysiphonella obliquisepta Zhang (L)
Amblysiphonella omanica Weidlich *et* Senowbari-Daryan (Z)
Amblysiphonella regularis Zhang (L)
Amblysiphonella sp. A (X)
Amblysiphonella sp. B (X)
Amblysiph. specialis Rigby, Fan *et* Zhang (LA)
Amblysiphonella vesiculosa minima Zhang (L)
Amblysiphonella yini Fan *et* Zhang (L)
Baryspongia beedei Wu (Z)
Belyaevaspongia insolita (Belyaeva) (Th)
Carterina gracilis Rigby, Fan *et* Zhang (J, Z, LA)
Carterina pyramidata Waagen *et* Wentzel (LA)
Colospongia cf. *dubia* Laube (L)
Colospongia cortexifera Senowbari-Daryan *et* Rigby Wu (J, Z)
Colosp. gemina (Waagen *et* Wentzel)) (Z, L)
Colospongia maxima Rigby, Fan *et* Zhang (X)
Colospongia sp. (Th)
Colospongia sp. (Z)
Colospongia spheroida Wu (Z)
Colospongia tubiformis Wu (Z)
Diecithalamia permica Wu (Z)
Discosiphonella asiatica (Fan *et* Zhang) (L, X)
Discosiphonella heteroideus Wu (Z)
Discosiphonella lepida (Zhang) (L)
Discosiphonella orientalis (Fan *et* Zhang) (L)
Discosiphonella ostiolata Wu (Z)
Discosiphonella spongioformis Wu (Z)
Discosiphonella typica (Zhang) (L, X)
Discosiphonella variabilis (Zhang) (L)
Drupinella irregulara Wu (Z)
? Girtyocoelia beedei (Girty) Wu (Th)
Girtyocoelia fibrilata Wu (Z)
Girtyocoelia sp. (L)
Guadalupia cylindrica Girty (Z)
Guadalupia irregulara Wu (Z)
Guadalupia minima Parona (Z)
Huayingia glomerata Rigby, Fan, Wang *et* Zhang (J)
Imbricatocoelia elongata Rigby, Fan *et* Zhang (X)
Intrasporeocoelia hubeiensis Fan *et* Zhang (Z, L, Th)
Monocoelia flata Wu (Z)
Neoguadalupia explanata Rigby, Fan *et* Zhang (X)
Pachycoelia siphonella Wu (Z)
Parauvanella cylindrica Wu (Z)
Parauvanella irregulara Wu (Z)
Parauvanella maxima Wu (Z)
Parauvanella minima Senowbari-Daryan Wu (LA)
Parauvanella minima Senowbari-Daryan) (L)
Parauvanella paronai Senowbari-Daryan *et* Di Stefano (Wu) (J, Z)
Parauvanella sp. (L)
Parauvanella spinosa Wu (Z)
Phraethalamia tubulara Senowbari-Daryan *et* Ingavat-Helmcke (Th)
Pinacophyllum orthocera Wu (Z)
Pinacophyllum parallela Wu (Z)
Polycystocoelia asiatica (Fan *et* Zhang) (L, X)
Polycystocoelia huajiaopingensis Zhang (X, Z, J)
Polycystocoelia sinica Zhang (L)
Polycystocoelia sp. (Z)
Polytholosia tubifera Wu (Z)
Preverticillites columnella (Parona) Wu (X)
Pseudodeningeria pachyphloeus Wu (Z)
Rahbahthalamia bullifera (Senowbari-Daryan *et* Rigby) (Z)
Rhabdactinia columnaria Yabe *et* Sugiyama (X, Z)
Rhabdac. irregulara Rigby, Fan *et* Zhang (Z)
Rhabdactinia regulara Wu (Z)
Salzburgia irregulara Wu (Z)
Salzburgia permica Wu (Z)
Solenolmia ? sp. (Z)
Sollasia angulara Wu (Z)
Sollasia irregulara Wu (Z)
Sollasia minima Wu (Z)
Sollasia ostiolata Steinmann (J, Z, Th)
Sollasia sp. (L)
Sollasia spheroida ? (Rigby, Fan *et* Zhang) Wu (Th)
Sollasia tubiformis Wu (Z)
Spinocoelia spinosa Wu (Z)
Stromatogloma typica Wu (Z)
Subascosymplegma ? paracatenulata Rigby, Fan *et* Zhang (X)
Subascosymplegma sp. (Z)
Tebagathalamia minima Wu (Z)
Tristratocoelia rhythmica Senowbari-Daryan *et*

Rigby (Th)
Uvanella micritica Wu (Z)

4 Thalamid sponges in Middle Triassic Anisian and Ladinian reefs

According to our examination, the following thalamid species from Anisian and Ladinian reefs have been confirmed (The letter in "()" indicates the occurrence locality. A: Northern Alps; D: Western Dolomite; ID: Italian Dolomites; H: Hungary):

Alpinothalamia bavarica (Ott) (A)
Anisothalamia minima Senowbari-Daryan *et al.* (ID)
Celyphia ? minima Senowbari-Daryan *et al.* (ID)
Celyphia zoldana Ott, Pisa *et* Farabegoli (ID)
Colospongia catenulata (D)
Colospongia catenulata catenulata Ott (A)
Colosp. catenulata macrocatenulata Scholz (H)
Colospongia sp. (ID)
Cryptocoelia manon manon (Munster) (A)
Cryptocoelia zitteli Steinmann (D)
Deningeria crassireticulata Senowbari-Daryan *et al.* (ID)
Deningeria tenuireticulata Senowbari-Daryan *et al.* (ID)
Diecithalamia polysiphonata Dieci, Antonacci *et* Zardini (A)
Follicatena cautica Ott (A, D)
Girtyocoelia oenipontana Ott (D)
Olangocoelia otti Bechstadt *et* Brandner (ID)
Sestrocatena alpinus (Ott) (D, A)
Solenolmia (= Dictyocoelia) manon (D)
Thaumastocoelia ? dolomitica Senowbari-Daryan *et al.* (?, Wu) (ID)
Uvanella irregularis Ott (D, A)
Uvanella norica Senowbari-Daryan (ID)
Vesicocaulis depressus Ott (A, D)

5 Thalamid sponges in Late Triassic Carnian reefs

According to our examination, the following thalamid species from Carnian reefs have been confirmed (The letter in "()" indicates the occurrence locality. G: Greek island; O: Oman Mountains; C: Civetta, Dolomites; D: Dolomites):

Amblysiphonella cf. *lorentheyi* Vinassa De Regny (G)
Amblysiphonella lorentheyi Vinassa (D)
Amblysiphonella minima Senowbari-Daryan *et* Shafer (G)
Amblysiphonella strobiliformis Dieci, Antonacci *et* Zardini (D)
Amblysiphonella timorca Vinassa (D)
Aplinothalamia bavarica Ott (D)
Aplinothal. slovenica (Senowbari-Daryan) (O)
Ascosymplegma expansum Seilacher (D)
Celyphia submarginata (Munster) (D)
Ceotinella mirunae Pantic (G, O)
Colospongia andrusovi Jablonsky (G)
Colospongia catenulata catenulata Ott (G)
Colospongia cf. *elongata* (Wilckens) (G)
Colospongia dubia (Munster) (D, G)
Colospongia sp. 1 (G)
Colospongia sp. 2 (G)
Cryptocoelia lata Senowbari-Daryan *et al.* (G)
Cryptocoelia zitteli Steinmann (D, G, O)
Enoplocoelia armata (Klipstein) (D)
Follicatena cautica Ott (G)
Girtyocoelia ostiaesaccus Senowbari-Daryan (G)
Prosiphonella amplectens Dieci, Antonacci *et* Zardini (D)
Sestrocatena alpinus Ott (G)
Solenolmia (= Dictyocoelia) manon (Munster) (G, D)
Solenolmia (= Dictyocoelia) manon manon (Munster) (C, O)
? Solenolmia (= Dictyocoelia) manon (Munster) (G)
Stylothalamia dehmi Ott (G)
Thaumastocoelia cassiana Steinmann (D)
Uvanella ? lamellata Senowbari-Daryan (O)
Uvanella irregularis Ott (C, G)
Verticillites ? sp. 1 (G)
Verticillites cf. *cretaceus* Defrance (G)
Vesicocaulis carinthiacus Ott (G)
Vesicocaulis depress Ott (D)
Vesicocaulis multisiphonatus Kovacs (G)
Vesicocaulis polysiphonata Dieci, Antonacci *et* Zardini (D)
Vesicocaulis reticuliformis Jablonsky (G)
Zardinia ? sp. 2 (G)
Zardinia cf. *perisulcata* Dieci *et al.* (G)
Zardinia cf. *platithalamica* Dieci *et al.* (G)

Zardinia perisulcata Dieci, Antonacci *et* Zardini (D)
Zardinia platithalamica Dieci, Antonacci *et* Zardini (D)
Zardinia cylindrica Senowbari-Daryan and Shafer (G)
Zardinia sp. 1 (G)

6 Thalamid sponges in Late Triassic Norian-Rhaetian reefs

According to our examination, the following thalamid sponge species from Norian and Rhaetian reefs have been confirmed (The letter in "()" indicates the occurrence locality. S: Sicily; A: Northern Calcareous Alps; N: Nevada, USA; T: Turkey; Y: Yukon, Canada; G: Greece):

? Cryptocoelia zitteli Steinmann (Y)
Alpinothalamia minima (Senowbari-Daryan *et* Schafer) (S)
Amblysiphonella ? polyformis Senowbari-Daryan *et* Schafer (S)
Amblysiphonella sp. 1 (S)
Amblysiphonella sp. 2 (S)
Amblysiphonella sp. 3 (S)
Annaecoelia interiecta Senowbari-Daryan *et* Schafer (A)
Annaecoelia mirabilis Senowbari-Daryan *et* Schafer (A)
Antalythalamia riedeli Senowbari-Daryan (T)
Ascosymplegma expansum Seilacher (Y)
Battaglia major Senowbari-Daryan *et al.* (S)
Battaglia minor Senowbari-Daryan *et al.* (S)
Celyphia ? norica Senowbari-Daryan *et al.* (S)
Cheilosporites tirolensis Wahner (S, G)
Cinnabaria expansa (Seilacher) (N)
Cinnabaria minima Senowbari-Daryan (G)
Colospongia bimuralis Senowbari-Daryan (Y)
Colospongia cf. *menulensis* Senowbari-Daryan *et* Schafer (Y)
Colospongia dubia ? (Munster) Wu (Y)
Colospongia mennulensis Senowbari-Daryan *et* Schafer (S)
Cribrothalamia madoniensis Senowbari-Daryan (S)
Cryptocoelia crassiparietalis Senowbari-Daryan *et* Schafer (S)
Cryptocoelia lupensis Senowbari-Daryan (S)
Crypt. tenuiparietalis Senowbari-Daryan (S)
Discosiphonella ? sp. (S)
Follicatena irregularis Senowbari-Daryan *et* Schafer (S, Y)
Gigantothalamia ovoidalis Senowbari-Daryan (T)
Henricellum cf. *H. insigne* Wilckens (Y)
Madonia conica Senowbari-Daryan *et al.* (S)
Neoguadalupia ? norica Senowbari-Darytan *et* Stanley (N)
Nevadathalamia cylindrica (Seilacher) (N)
Panormida priscae Senowbari-Daryan (S)
Paradeningeria alpina Senowbari-Daryan *et* Schafer (A, Y)
Paradeningeria gruberensis Senowbari-Daryan *et* Schafer (A)
Paradeningeria sp. (S)
Paradeningeria weyli Senowbari-Daryan *et* Schafer (A)
Paravesicocaulis multiosculatus Kovacs (S)
Platythalamiella siciliana Senowbari-Daryan (S)
Polycystocoelia norica Senowbari-Daryan *et* Reid (Y)
Polycystocoelia sp. 1 (Y)
Polysiphospongia collesanensis Senowbari-Daryan *et* Schafer (S)
Polysiphospongia fluegeli Senowbari-Daryan *et* Schafer (S)
Polytholosia sp. 1 (S)
Polytholosia sp. 2 (S)
Polytholosia sp. 3 (S)
Pseudouvanella parallela Senowbari-Daryan (T)
Salzburgia ? sp. (Y)
Salzburgia variabilis Senowbari-Daryan *et* Schafer (A)
Solenolmia (= Dictyocoelia) ? sp. (S)
Solenolmia cf. *manon* (Munste) (Y)
Sollasia ? aff. *baloghi* Kovacs (S)
Sphaerothalamia vesiculifera Senowbari-Daryan (T)
Stylothalamia polysiphonata Senowbari-Daryan (T)
Thaumastocoelia ovoidalis Senowbari-Daryan (T)
Thaumastocoelia ? sphaeroida Senowbari-Daryan (T)

Uvanella ? irregularis Ott (Y)
Uvanella ? tegimentopora Senowbari-Daryan *et* Schafer (S)
Uvanella cf. *irregularis* Ott (S)
Verticillites conicus Senowbari-Daryan *et* Schafer (S)
Weidlichia cylindrica (Senowbari-Daryan) (S)
Weidlichia siciliana (Senowbari-Daryan) (S)
Welteria ? sp. (S)
Yukonella rigbyi Senowbari-Daryan *et al*. (Y)

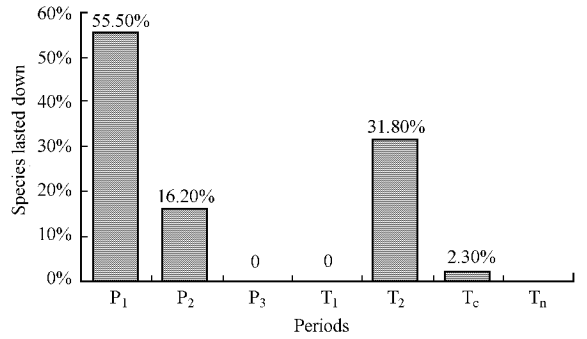
7 Comparison of the reefal thalamid sponges of different periods

As seen from Table 1 , the species diversity of reefal thalamid sponges was the lowest in Early Permian , but highest in Middle Permia.

As seen from Text-fig. 1 , only 16. 2 % of Middle Permian reefal thalamid species lasted into Late Permian. No Late Permian reefal thalamid species lasted into Triassic. Only 2. 3 % of Carnian reefal thalamid sponge species lasted into Norian-Rhaetian.

Flügel and Stanley (1984) once suggested some *Grityocoelia* lasted into Triassic. But afterward Flügel (1994) gave up such view of point and regarded Triasisic *Girtyocoelia* as homonym of some Permian thalamid sponges and the similarity between the Triassic *Amblysiphonella*, *Colospongia* and the Permian *Amblysiphonella*, *Colospongia* were just morphological.

Permian-Triassic evolution of reefal thalamid sponges indicates three extinction events: the first at the end of Middle Permian , which killed 83. 8 % of the Middle Permian reefal thalamid sponge species; the second at the end of Late Permian , which killed 100 % of the Late Permian reefal thalamid species; and the third at the end of Carnian, which killed 97. 7 % of the Carnian reefal halamid species.



Text-fig. 1　Reefal thalamid sponge species lasted into late period
P_1 = Early Permian; P_2 = Middle Permian; P_3 = late Late Permian (Changhsingian); T_1 = Early Triassic; T_2 = Anian - Lardinian; Tc = Carnian; Tn = Norian-Rhaetian

Table 1　Thalamid sponge species of Permian and Triassic periods

Period	Early Permian	Middle Permian	Late Permian	Middle Triassic	Carnian	Norian-Rhaetian
Total species	9	111	84	22	44	63
Species from last period		5	18	0	7	1