アマオブネガイ目と盤足目の中腸腺細管の構造

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アマオブネガイ目と盤足目の中腸腺細管の構造

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Structure of Tubule of Digestive Diverticula in Neritopsidae and Discopoda (PROSOBRANCHIA : GASTROPODA)

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Abstract : Tubules of digestive diverticula in 4 species of Neritopsidae and in 12 species of Discopoda were observed by means of the tissue preparations by Azan staining. In 4 species of Neritopsidae, the tubule grew from the places on the ducts which extended from the stomach, ramified by the Monopodial branching type and developed out at the digestive diverticula. In 12 species of Discopoda, the long duct with large diameter which grew from the stomach extended in the inside of the spiral digestive diverticula, and the ducts with small diameter extended outside the spiral digestive diverticula from the places on the long duct. The tubules outgrew from the ducts with both the large and the small diameters, ramified by the Dichotomous branching type and developed out at the digestive diverticula.

Key words : Neritopsidae; Discopoda; digestive diverticula; duct; tubule; tubule type

Nakazima[1] は軟体動物の中腸腺細管の型を，大きな萎んだ袋状を呈するMonopodial branching type（単軸分岐型），枝分かれを繰り返すDichotomous branching type（叉状分岐型）および導管の先端に同細管の小室が１～数個連結したSimple branching type（単分岐型）の３つに大別している。腹足綱前鰓亜綱古腹足目では，ミミガイ科およびスカシガイ科は単軸分岐型を，ニシキウズガイ科およびサザエ科は叉状分岐型を示すことが報告されている[1-3]。腹足綱前鰓亜綱盤足目（中腹足目）では，タマキビ科のタマキビ*Littorina brevicula*は単軸分岐型を[1]，タマガイ科のツメタガイ*Glossaulax didyma*は単分岐型を示すとされている[4]。以上のように，中腸腺細管の型は，古腹足目では，単軸分岐型から叉状分岐型へと変化し，前鰓亜綱盤足目では単軸分岐型から叉状分岐型を経て単分岐型へと変化するように考えられる。

本研究では，中腸腺細管の発達過程を明らかにする目的で，古腹足目に含められる場合もあるアマオブネガイ目および盤足目の中腸腺の構造を組織標本を用いて調べた。なお，分類は波部ら[5]，首藤[6]および奥谷[7]に従った。

材料および方法

実験には，アマオブネガイ目としてアマオブネガイ科Neritidaeのキバアマガイ*Nerita* (*Ritena*) *plicata*，オオマルアマオブネ*Nerita* (*Theliostyla*) *chammaeleon*，アマオブネガイ*Nerita* (*Theliostyla*) *albicilla*およびアマガイ*Nerita* (*Heminerita*) *japonica*の４種を，盤足目としてタニシ科Vivipariidaeのマルタニシ*Cipangopaludina chinensis laeta*，ウミニナ科Batillariidaeのウミニナ*Batillaria multiformis*，フトヘナタリ科PotamididaeのフトヘナタリCerithidea (*Cerithidea*) *rhizophorarum*，ヘナタリCerithidea (*Cerithideopsilla*) *cingulata*，カワアイCerithidea (*Cerithideopsilla*) *djadjariensis*，カワニナ科PleuroceridaeのカワニナSemisulcospira *libertina*，タマキビ科LittorinidaeのタマキビLittorina (*Littorina*) *brevicula*，ソデボラ科StrombidaeのシドロガイStrombus (*Doxander*) japonicus，スズメガイ科HipponicidaeのキクスズメHipponix *conica*，ムカデガイ科VermetidaeのオオヘビガイSerpulorbis *imbrica-*

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Table 1. The size of animals used for this study

	Shell length (mm)	Shell width (mm)	Total body weight (g)	n
Neritimorpha				
Neritidae				
Nerita (*Ritena*) *plicata*	15.2 ± 1.0	17.4 ± 1.2	2.6 ± 1.3	6
Nerita (*Theliostyla*) *chammaeleon*	19.8 ± 2.6	22.9 ± 2.7	4.9 ± 1.6	18
Nerita (*Theliostyla*) *albicilla*	13.1 ± 1.2	15.4 ± 1.6	2.0 ± 1.2	8
Nerita (*Heminerita*) *japonica*	11.0 ± 1.0	14.7 ± 1.5	1.1 ± 0.4	30
Discopoda				
Viviparidae				
Cipangopaludina chinensis laeta	31.4 ± 3.3	25.3 ± 2.1	3.8 ± 1.7	28
Batillariidae				
Batillaria multiformis	18.3 ± 1.2	7.2 ± 0.7	0.5 ± 0.1	28
Potamididae				
Cerithidea (*Cerithidea*) *rhizophorarum*	38.0 ± 3.1	1.6 ± 0.3	2.9 ± 1.2	9
Cerithidea (*Cerithideopsilla*) *cingulata*	30.1 ± 1.8	1.4 ± 0.4	2.2 ± 0.6	11
Cerithidea (*Cerithideopsilla*) *djadjariensis*	35.6 ± 2.5	12.7 ± 1.9	3.1 ± 0.6	6
Pleuroceridae				
Semisulcospira libertina	25.7 ± 2.2	13.9 ± 2.6	2.6 ± 0.7	17
Littorinidae				
Littorina (*Littorina*) *brevicula*	11.5 ± 1.2	10.4 ± 0.9	0.6 ± 0.2	20
Strombidae				
Strombus (*Doxander*) *japonicus*	58.4 ± 0.8	29.7 ± 1.7	16.6 ± 0.9	3
Hipponicidae				
Hipponix conica	23.4 ± 4.1	17.0 ± 2.3		12
Vermetidae				
Serpulorbis imbricatus			16.8 ± 8.1	3
Cypraeidae				
Cypraea (*Purpuradusta*) *gracilis*	15.2 ± 1.4	9.2 ± 0.7	0.7 ± 0.3	15
Bursidae				
Bufonaria rana	101.1 ± 4.3	59.0 ± 2.8	36.1 ± 7.4	6

Data showed mean ± standard deviation.
n indicated the individual numbers.

tus, タカラガイ科Cypraeidaeのメダカラ*Cypraea*(*Purpuradusta*) *gracilis*およびオキニシ科Bursidaeのミヤコボラ*Bufonaria rana*の12種を用いた（Table 1）。貝は水産大学校に隣接する海岸で採集した。なお，マルタニシおよびカワニナは水産大学校の小野臨湖実験実習場で採集した。これらの貝は，水槽（60 *l*）で畜養して2週間以上絶食させ，約0.4 Mの塩化マグネシウム水溶液[8]に10時間以上浸漬して体を伸展させ，殻を除去してDavidson液[9]で固定した。組織像は，常法に従ってパラフィン切片（10 μm）を作成し，アザン染色を施して観察した[2]。

結果および考察

アマオブネガイ目ではキバアマガイ（Fig. 1），オオマルアマオブネ（Fig. 2），アマオブネガイ（Fig. 3）およびアマガイ（Fig. 4）の4種において，房状を呈した中腸腺細管が胃から中腸腺の周囲に向けて伸びている導管の所々から出ていた。古腹足目の場合，ミミガイ科のクロアワビ*Haliotis discus discus*や[2,3]，スカシガイ科のオトメガサ*Scutus* (*Aviscutum*) *sinensis*において[2]，中腸腺細管は，導管の所々から大きな萎んだ袋状を呈して出ていることが報告されている。これらのことから，前記のアマオブネガイ目4種の中腸腺細管は，クロアワビ，メガイアワビ*Haliolis gigantea*，オキナワイシダタミ*Monodonta labio*[1]やスカシガイ科のオトメガサガイと同様に，単軸分岐型を示すことが明らかとなった。

古腹足目のニシキウズガイ科のクボガイ*Chlorostoma lishkei*，ヘソアキクボガイ*C. turbinatum*，クマノコガイ*C. xanthostigma*，コシダカガンガラ*Omphalius rusticus*，イシダタミ*Monodonta labio* from *confusa*およびクロツゲガイ*M. neritoides*の6種，およびサザエ科のサザエ*Turbo* (*Batillus*) *cornutus*，スガイ*T.* (Lunella) *cornutus correnisis*およびウラウズガイ*Astralium haematragum*の3種の中腸腺細管の先端は，枝分かれし，叉状分岐型を示すことが報告されている[2]。盤足目のマルタニシ（Fig. 5），ウミニナ（Fig. 6），フトヘナタリ（Fig. 7），ヘナタリ（Fig. 8），

カワアイ（Fig. 9），カワニナ（Fig. 10），タマキビ（Fig. 11），シドロガイ（Fig. 12），キクスズメ（Fig. 13），オオヘビガイ（Fig. 14），メダカラ（Fig. 15），ミヤコボラ（Fig. 16）の12種でも同様に，中腸腺細管は導管から伸びた後，枝分れをする叉状分岐型であることが明らかとなった。しかし，マルタニシ（Fig. 5），ウミニナ（Fig. 6），フトヘナタリ（Fig. 7），ヘナタリ（Fig. 8），カワアイ（Fig. 9），カワニナ（Fig. 10），タマキビ（Fig. 11），シドロガイ（Fig. 12），キクスズメ（Fig. 13），オオヘビガイ（Fig. 14），メダカラ（Fig. 15），ミヤコボラ（Fig. 16）の12種の盤足目の貝類では，導管は中腸腺の螺旋状の内側を胃から殻頂に向けて太い管となって伸び，その所々から中腸腺の螺旋状の外側に向けて枝分かれしていた。古腹足目のクロアワビやオトメガサでは，導管は，胃から中腸腺の周囲に向けて伸び，その所々から中腸腺細管が出ていることが報告されている[2]。カサガイ目のヨメガカサガイ亜目ヨメガカサガイ科のヨメガカサ*Cellana toreuma*，マツバガイ*C. nigrolineata*およびベッコウガサ*C. grata*，エンスイカサガイ亜目ユキノカサガイ科のウノアシ*Patelloida saccharina* from *lanx*およびコウダカアオガイ*Nipponacmea concinna*の 5 種，および古腹足目のニシキウズガイ科のクボガイ，ヘソアキクボガイ，クマノコガイ，コシダカガンガラ，イシダタミおよびクロツゲガイの 6 種，サザエ科のサザエ，スガイおよびウラウズガイの 3 種の導管は，極短かく，胃から伸びた後直ちに中腸腺細管に連なり，中腸腺細管は，導管から出た後 1 本の太い管となって螺旋状の中腸腺の内側を先端に向けて伸びていることが報告されている[2]。このように，盤足目12種の導管は，前記のカサガイ目 5 種および古腹足目 9 種のものと構造が異なり，よく発達した型を示していた。しかも，盤足目12種の導管は，古腹足目ニシキウズガイ科 6 種およびサザエ科 3 種での中腸腺細管の太い一本の管とほぼ同じ位置を占め，同じ形状を示して中腸腺の螺旋状の内側を先端に向けて 1 本の太い管となって伸びていることが確認された。

以上のことから，アマオブネガイ目の中腸腺細管は単軸分岐型を，盤足目の中腸腺細管は叉状分岐型を示すことが明らかとなった。

要　約

腹足綱での中腸腺細管の発達過程を明らかにする目的で，前鰓亜綱アマオブネガイ目 4 種および盤足目12種を用いて，中腸腺を組織標本から調べた。アマオブネガイ目 4 種の中腸腺細管は，胃から中腸腺の周囲に向けて伸びている導管の所々から単軸分岐型を示して出ていた。盤足目12種の中腸腺細管は，中腸腺の内側を先端に向けて 1 本の太い管となって伸びている導管のおよびそれから枝分かれした導管の所々から叉状分岐型を示して出ていた。

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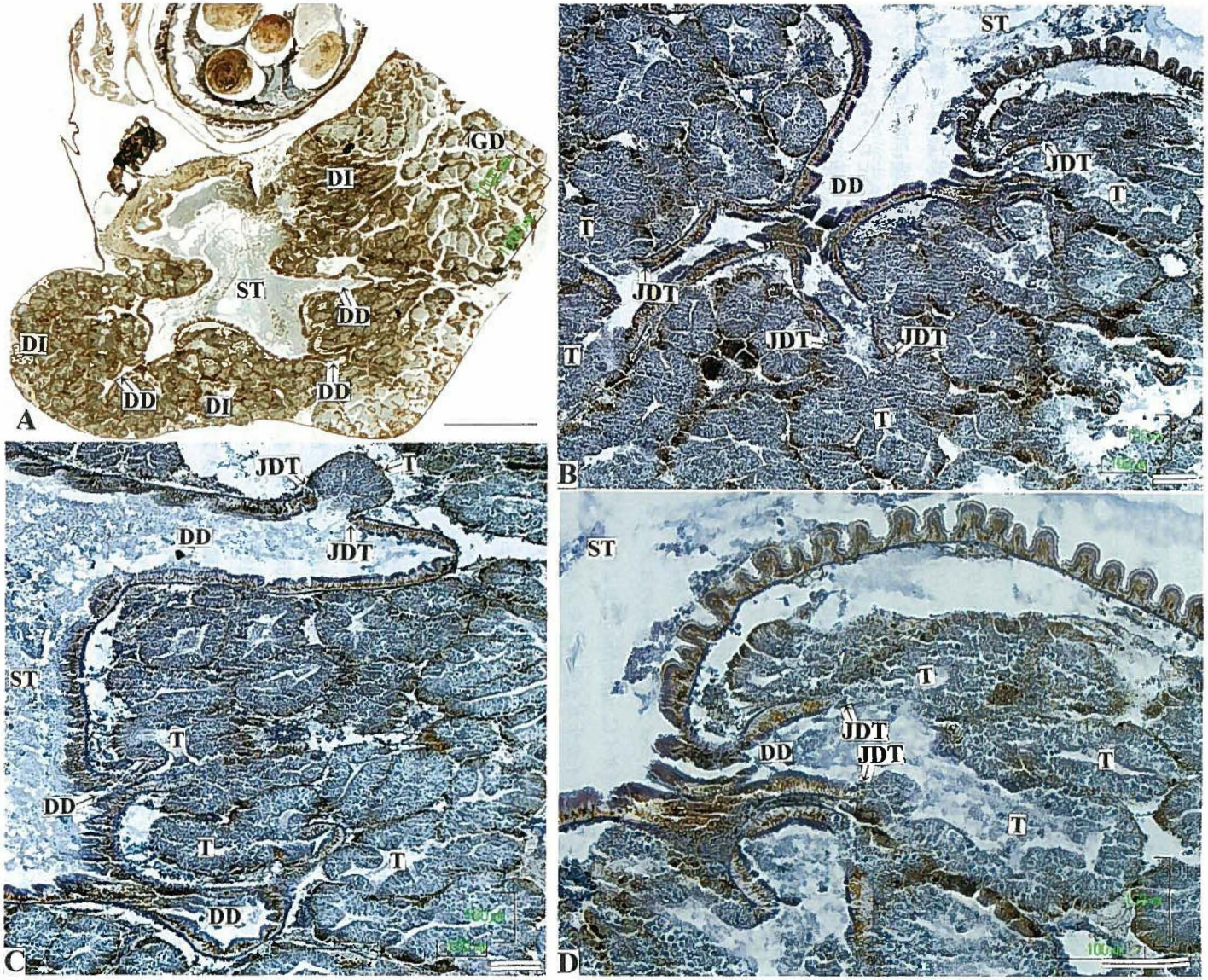

Fig. 1-1. Longitudinal sections of digestive diverticula of *Nerita* (*Ritena*) *plicata* (Neritimorpha: Neritoidae). ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

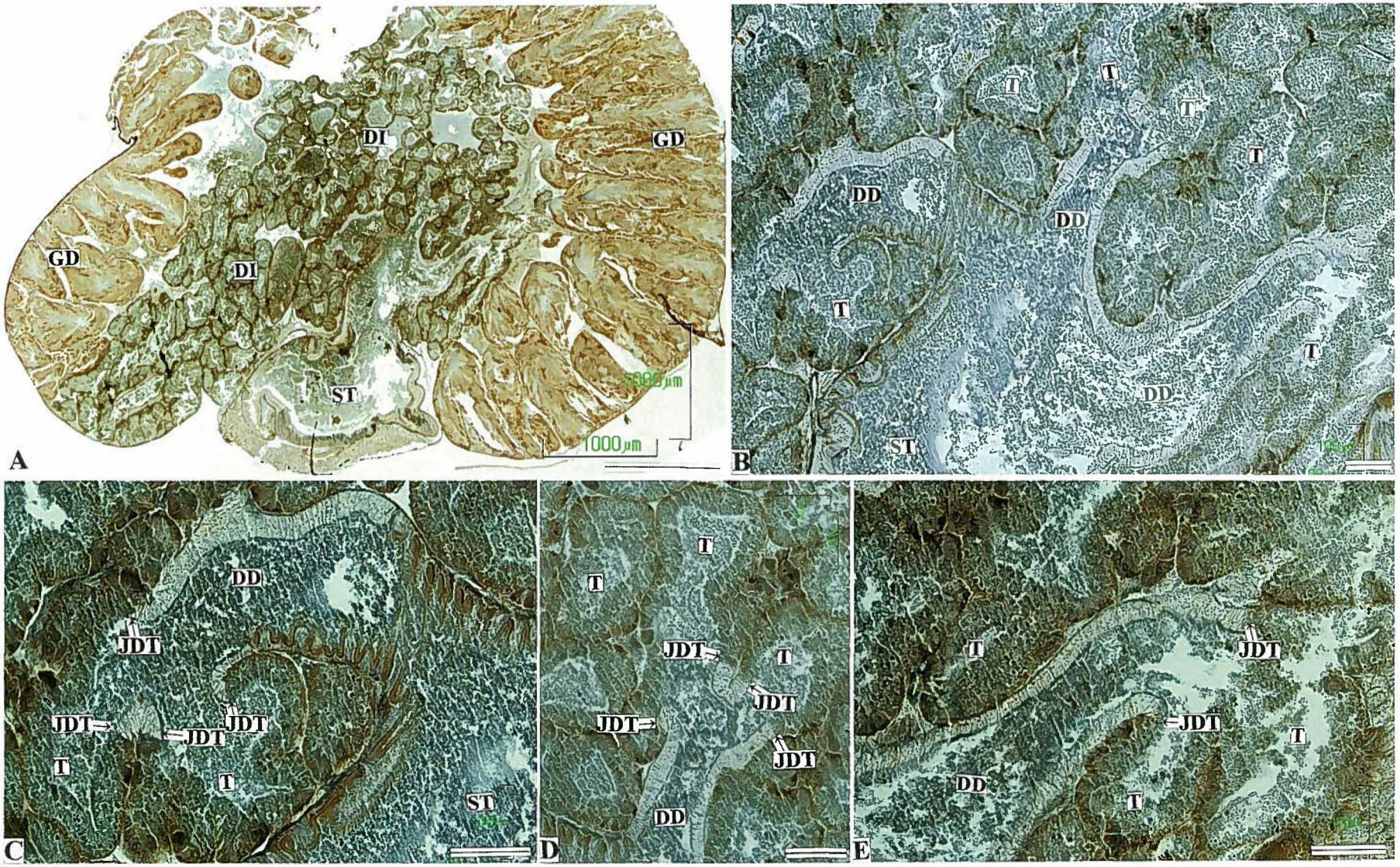

Fig. 1-2. Longitudinal sections of digestive diverticula of *Nerita* (*Ritena*) *plicata*. ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-E = 100 μm.

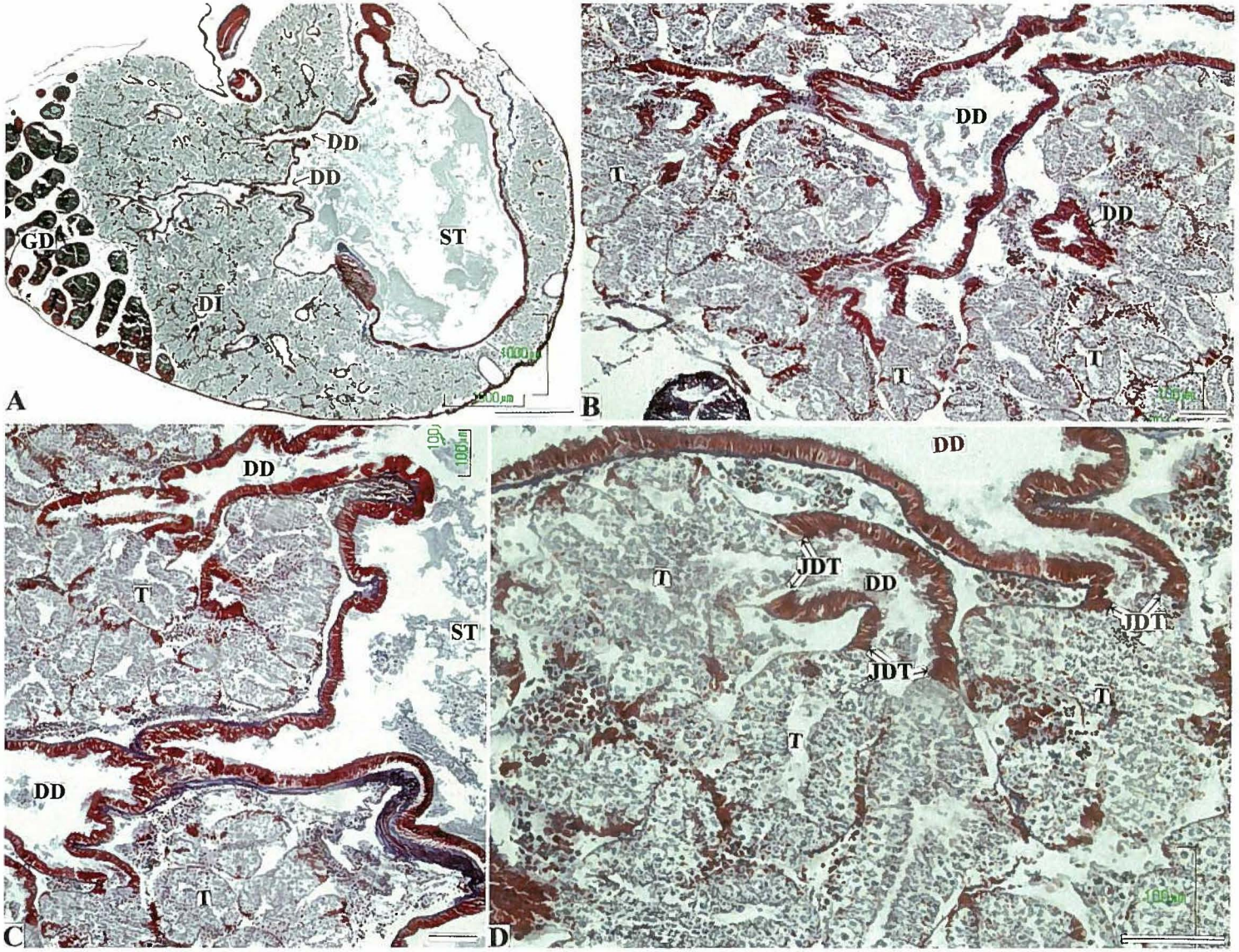

Fig. 2-1. Longitudinal sections of digestive diverticula of *Nerita* (*Theliostyla*) *chammaeleon* (Neritimorpha: Neritoidae). ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

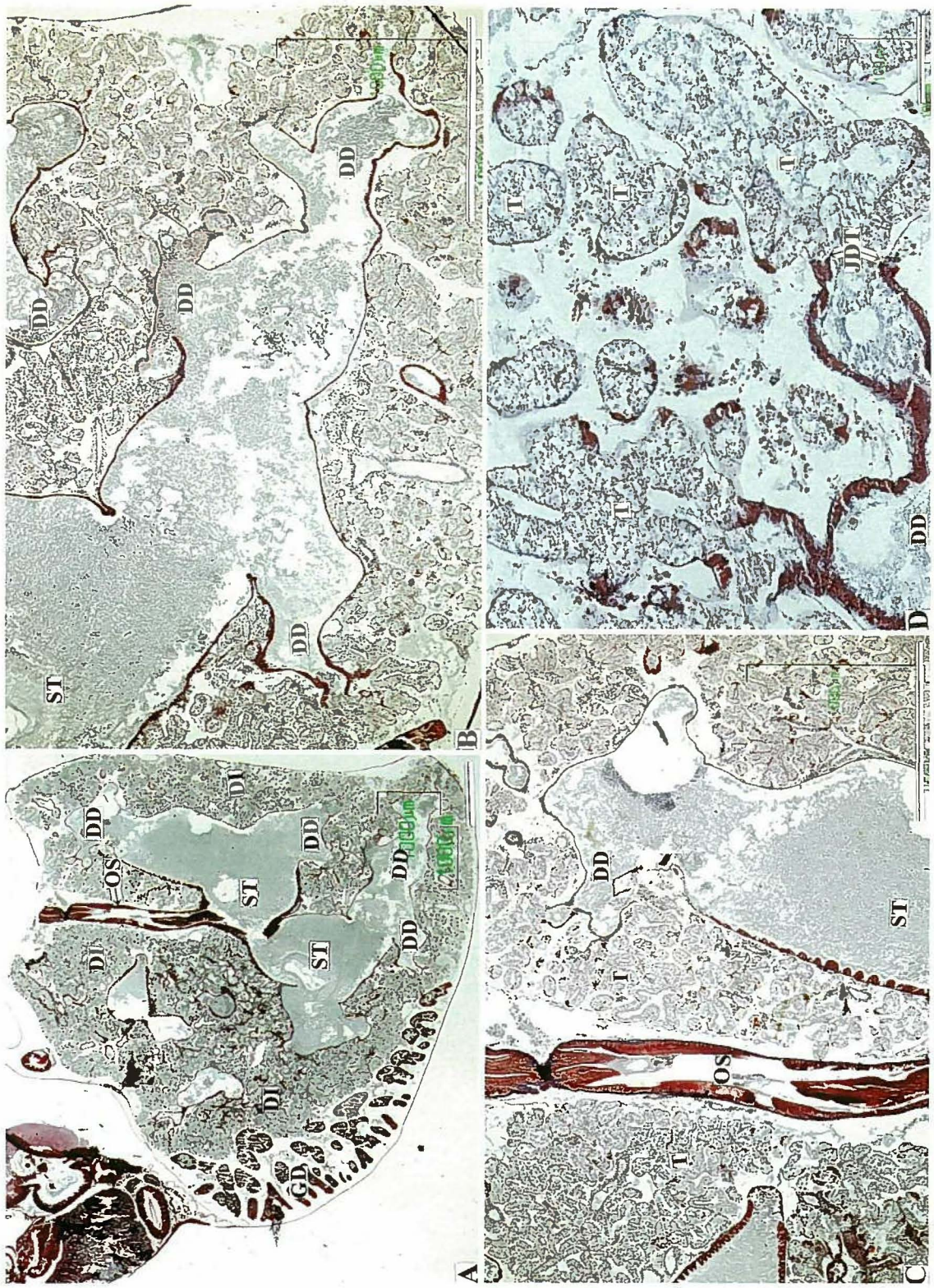

Fig. 2-2. Longitudinal sections of digestive diverticula of *Nerita* (*Theliostyla*) *chammaeleon*. ST, stomach; GD, gonad; OS, oesophagus; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

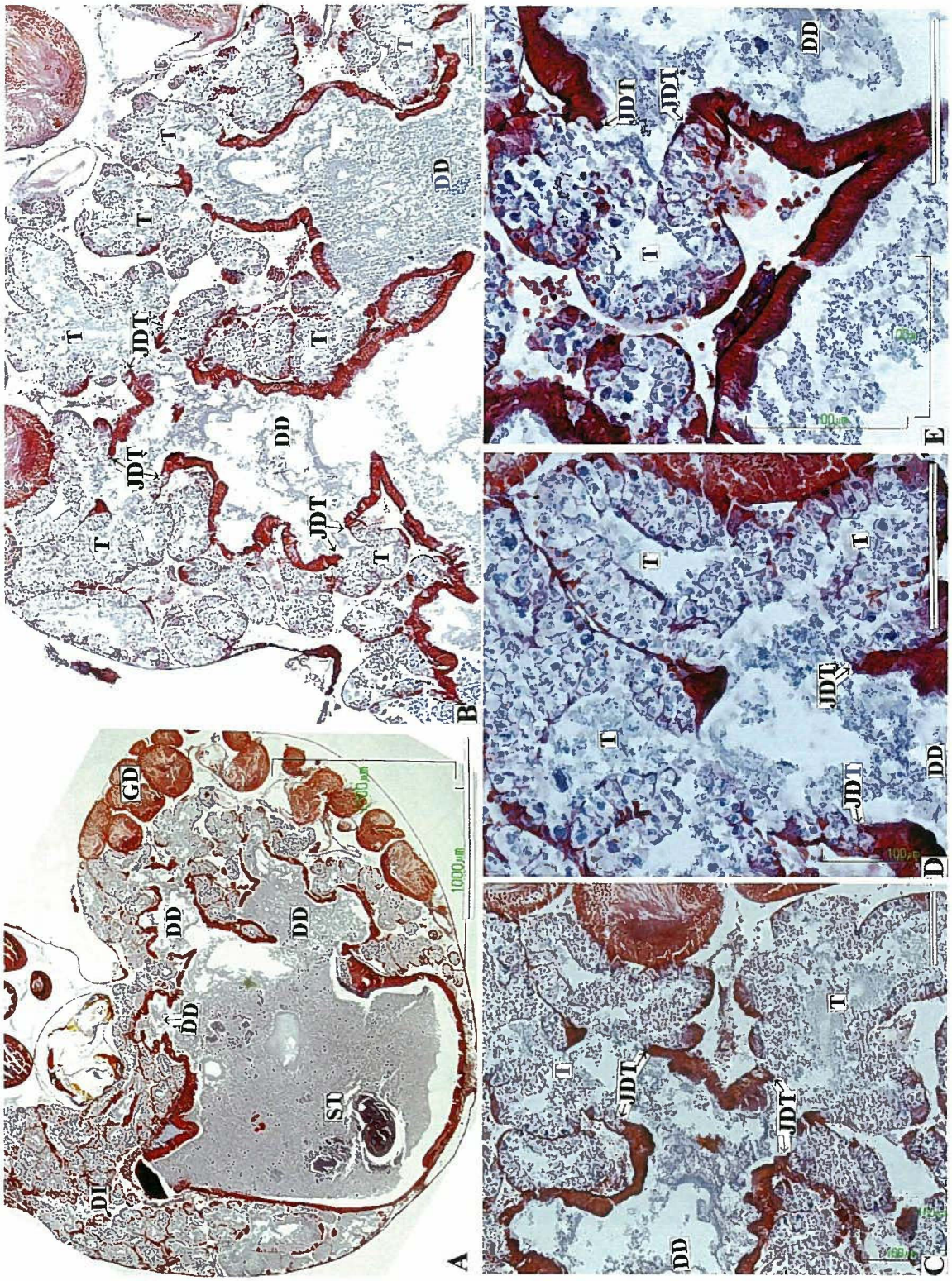

Fig. 3-1. Longitudinal sections of digestive diverticula of *Nerita* (*Theliostyla*) *albicilla* (Neritimorpha: Neritoidae). ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-E = 100 μm.

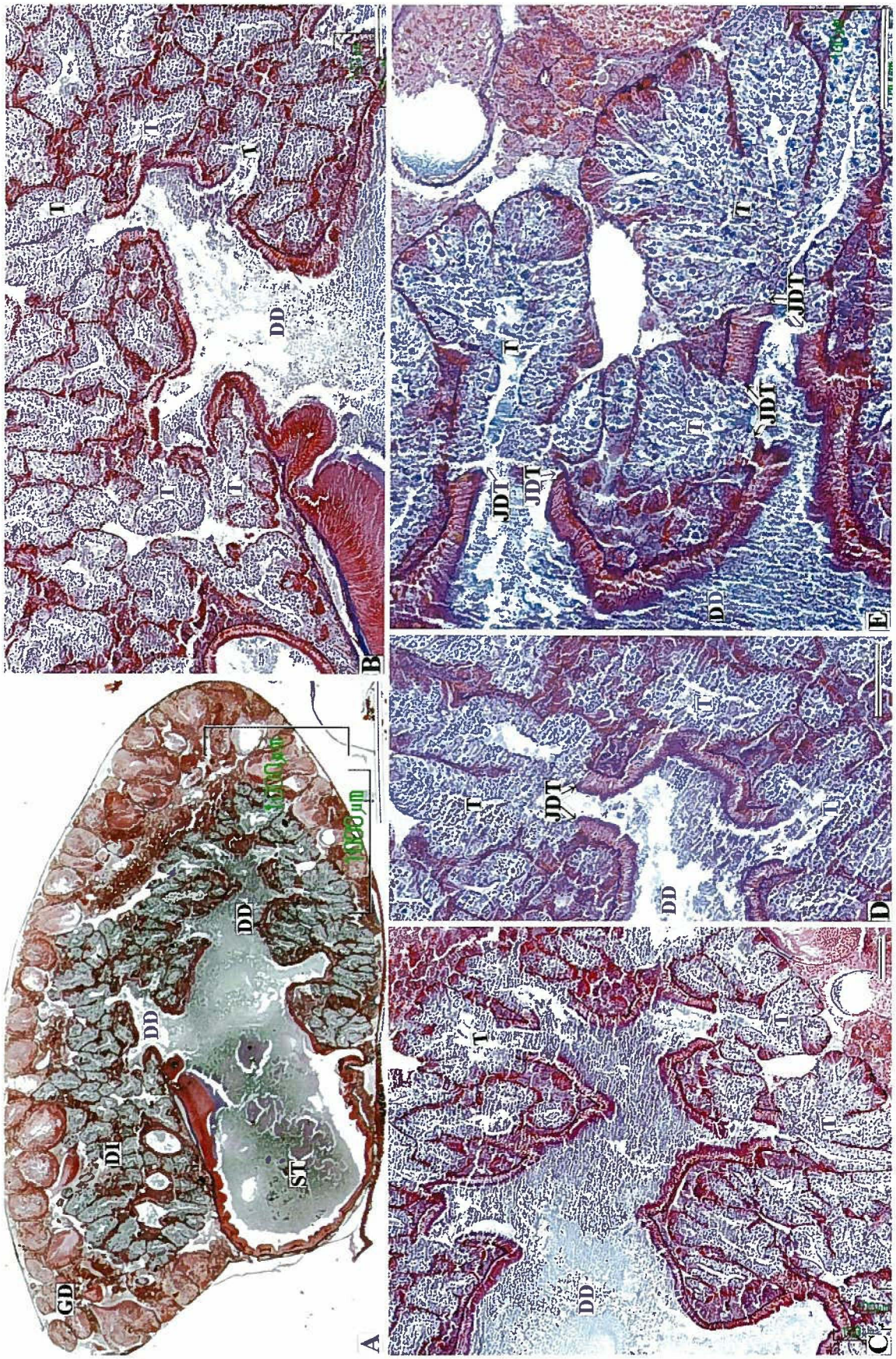

Fig. 3-2. Longitudinal sections of digestive diverticula of *Nerita* (*Theliostyla*) *albicilla*. ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-E = 100 μm.

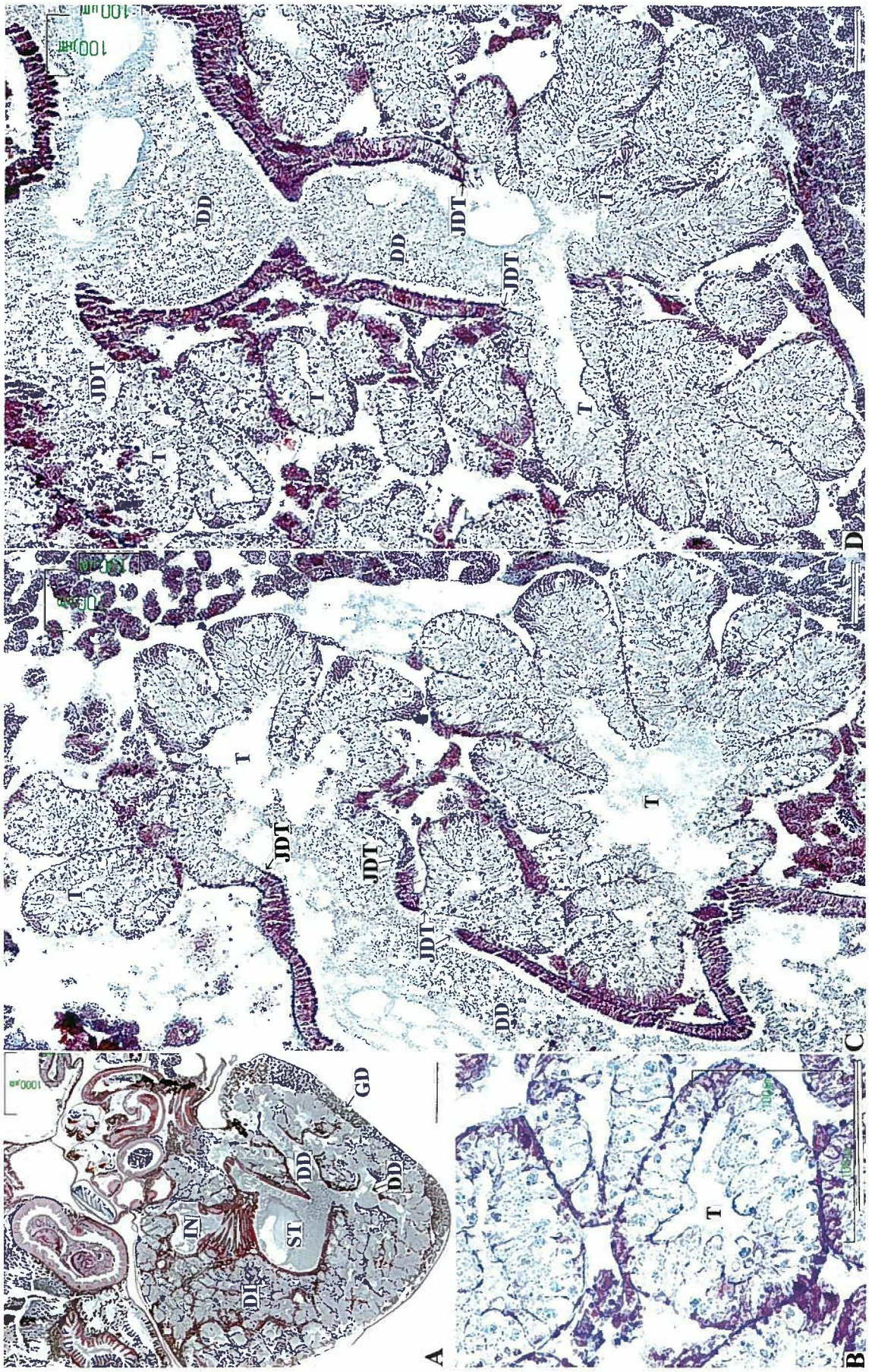

Fig. 4-1. Longitudinal sections of digestive diverticula of *Nerita* (*Heminerita*) *japonica* (Neritimorpha: Neritoidae). ST, stomach; IN, intestine; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

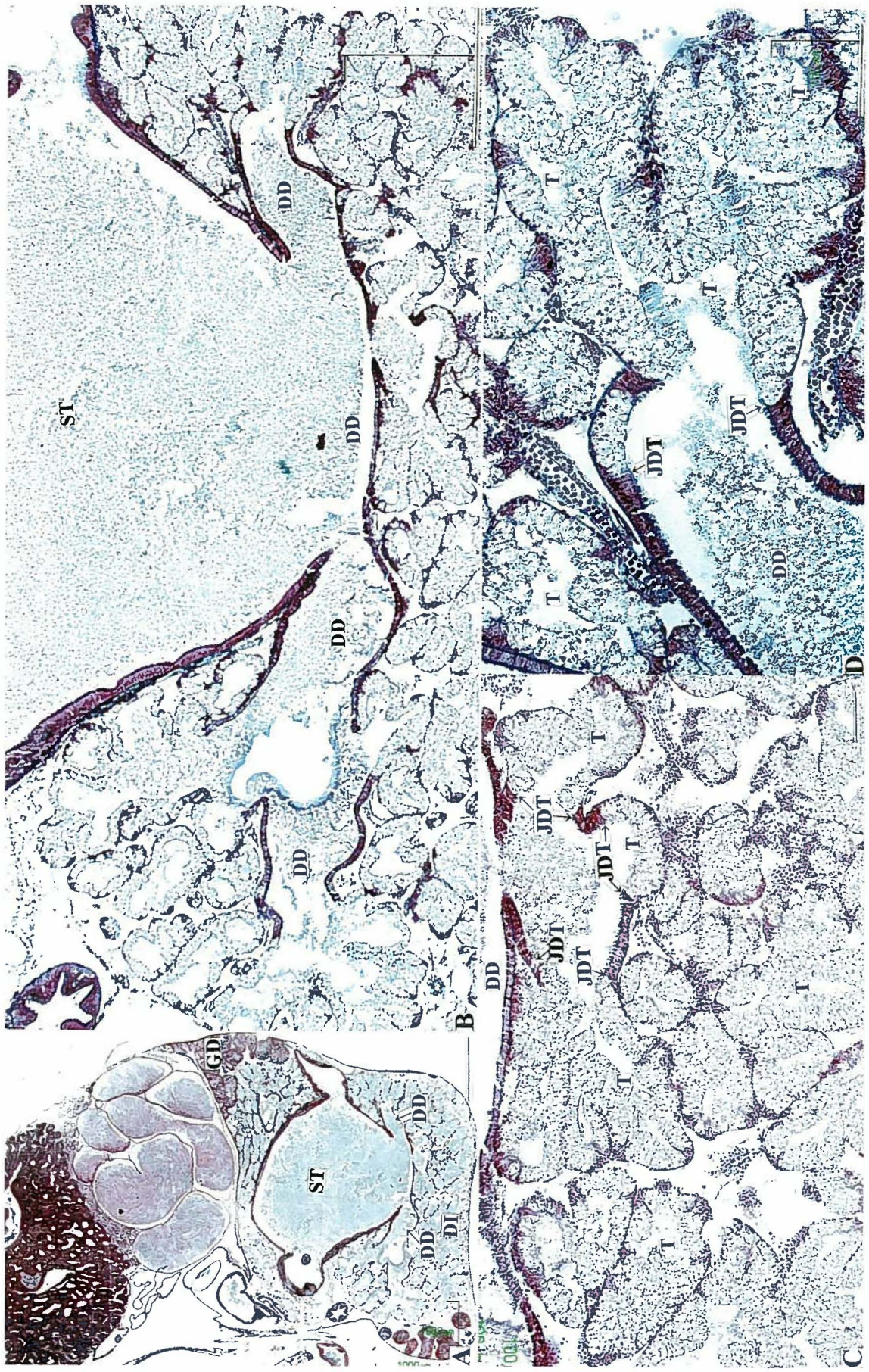

Fig. 4-2. Longitudinal sections of digestive diverticula of *Nerita* (*Heminerita*) *japonica* . ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μ m.

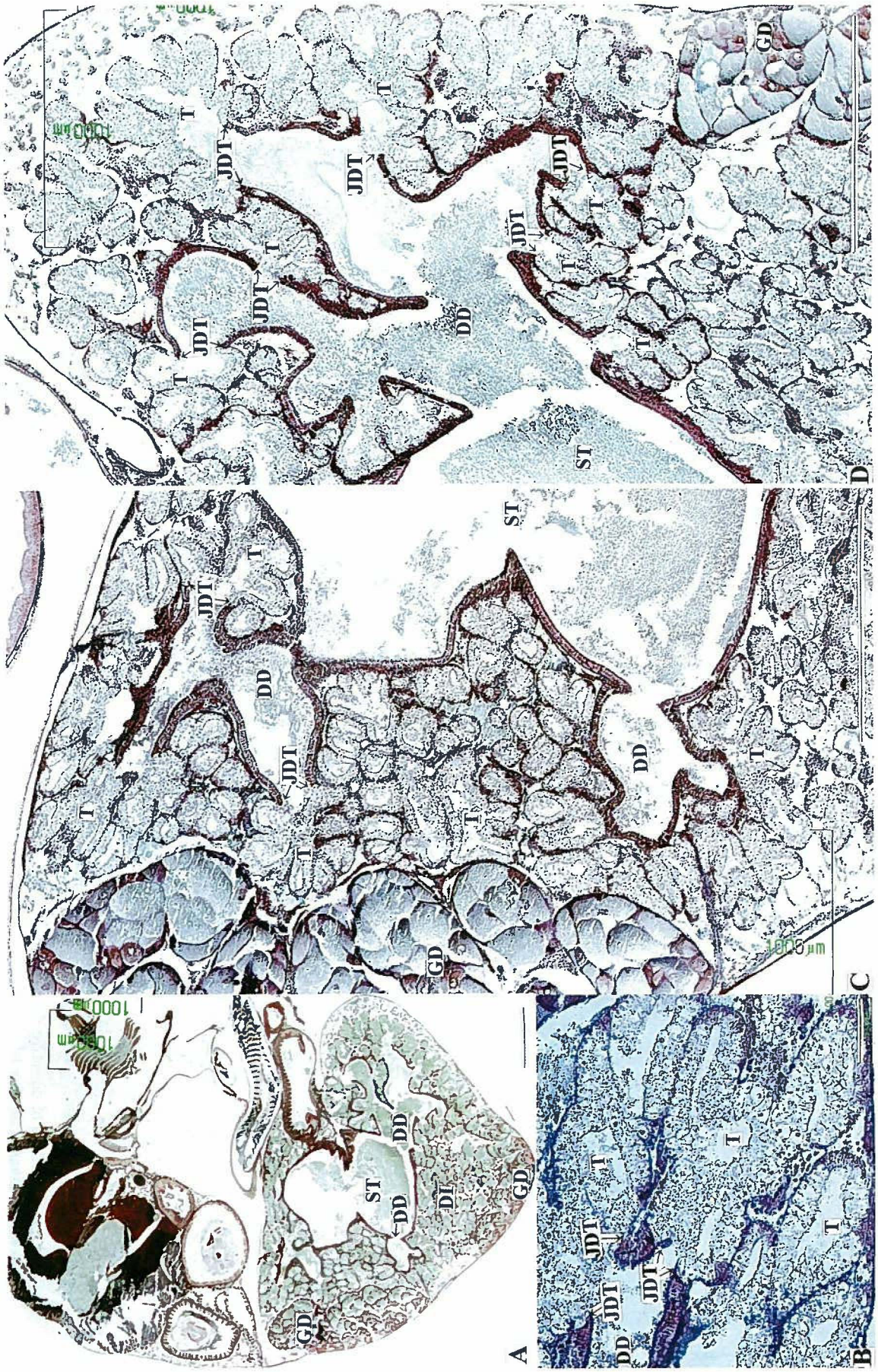

Fig. 4-3. Longitudinal sections of digestive diverticula of *Nerita* (*Heminerita*) *japonica* . ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

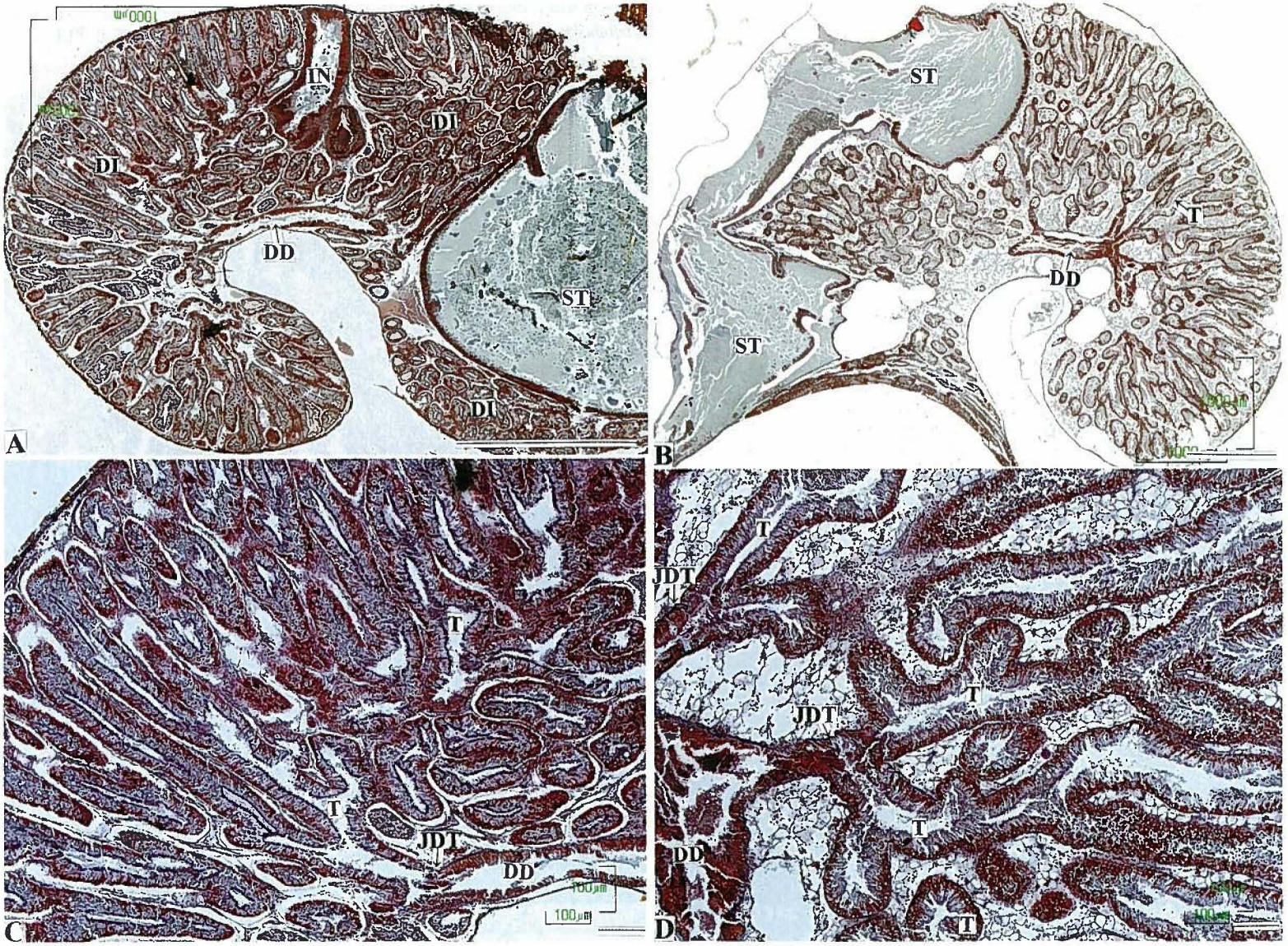

Fig. 5-1. Longitudinal sections of digestive diverticula of *Cipangopaludina chinensis laeta* (Discopoda: Viviparidae). ST, stomach; IN, intestine; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bars in C and D = 100 μm.

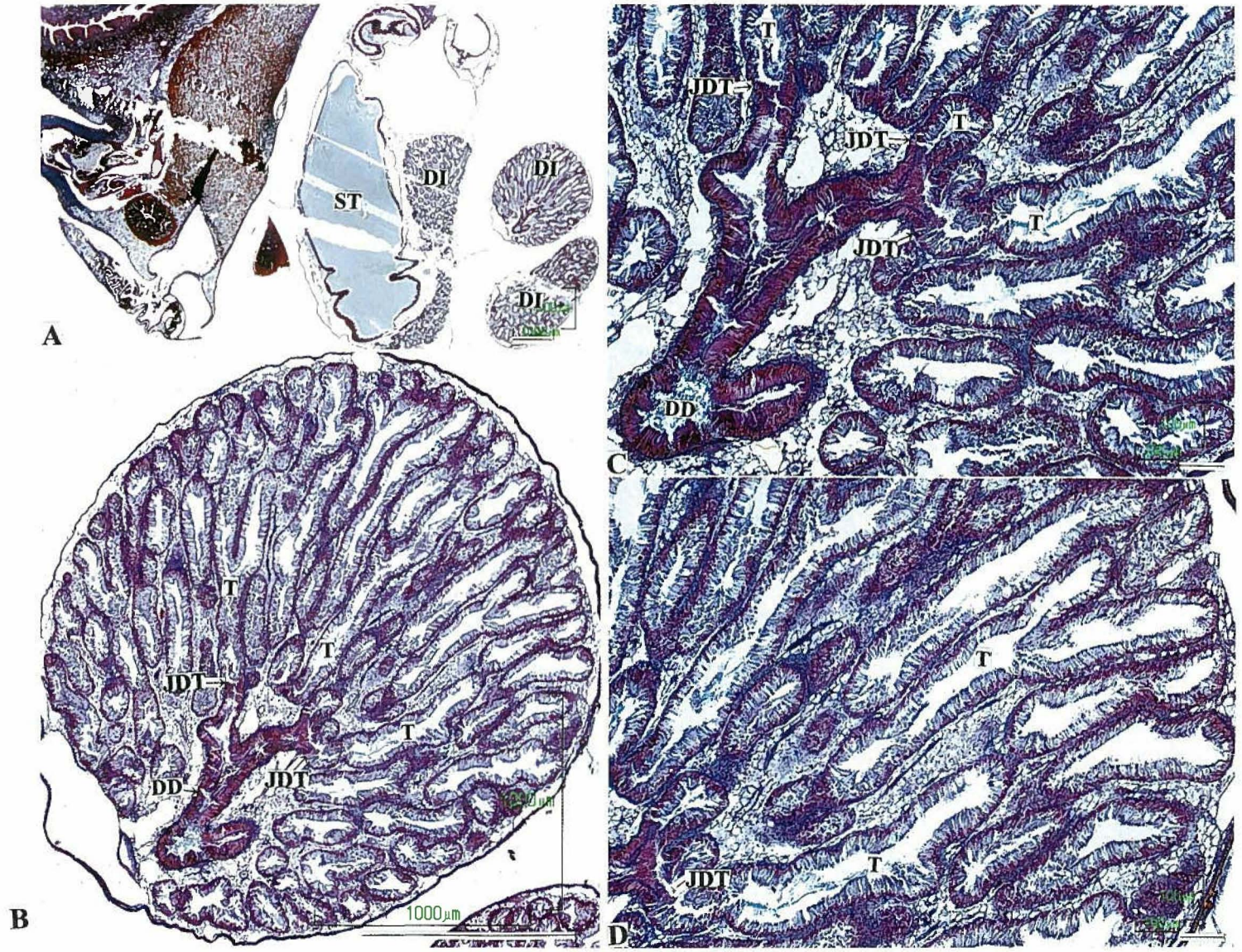

Fig. 5-2. Longitudinal sections of digestive diverticula of *Cipangopaludina chinensis laeta*. ST, stomach; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bars in C and D = 100 μm.

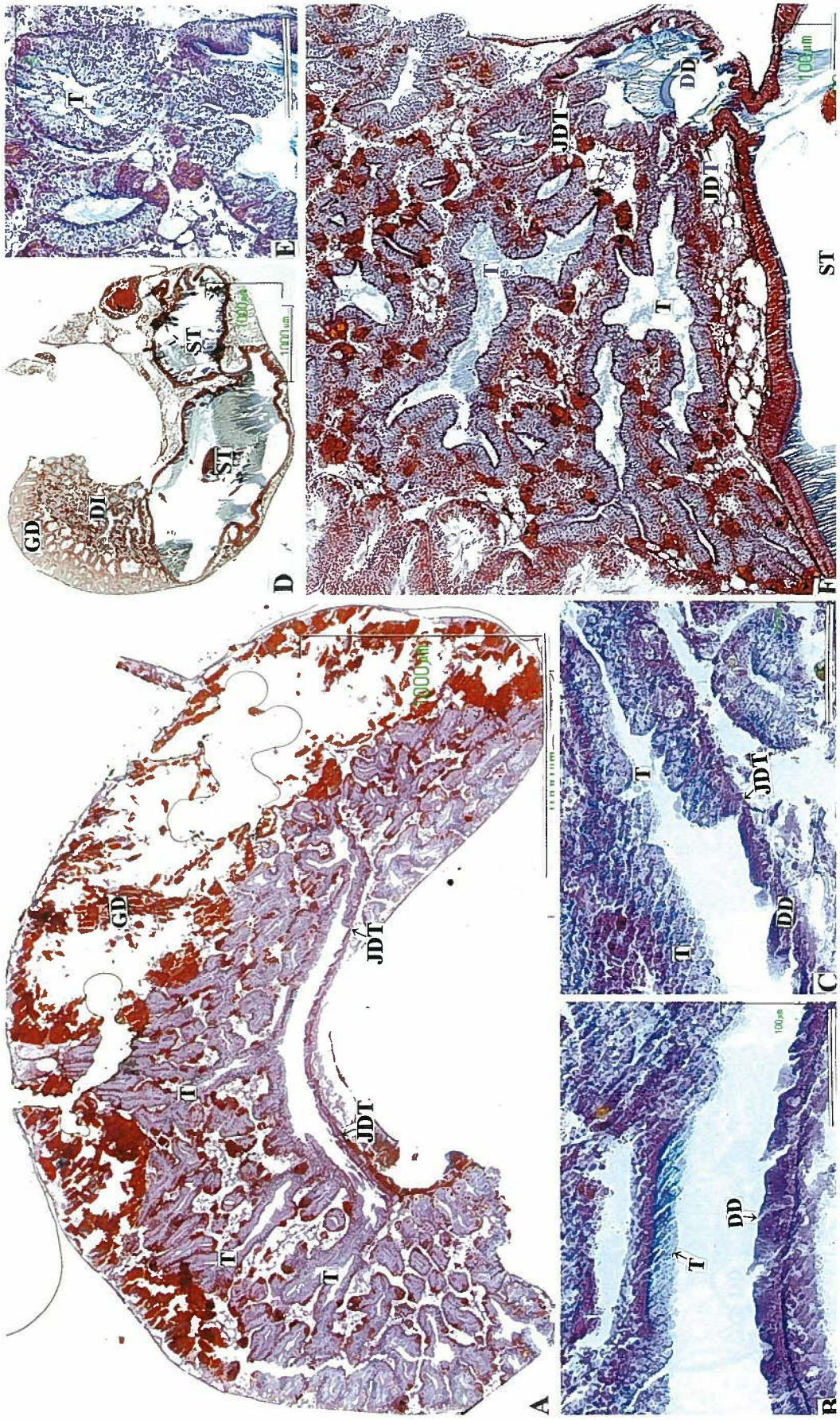

Fig. 6-1. Longitudinal sections of digestive diverticula of *Batillaria multiformis* (Discopoda: Batillariidae). ST, stomach; DI, digestive diverticula; GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and D = 1 mm, and bars in B, C, E and F = 100 μm.

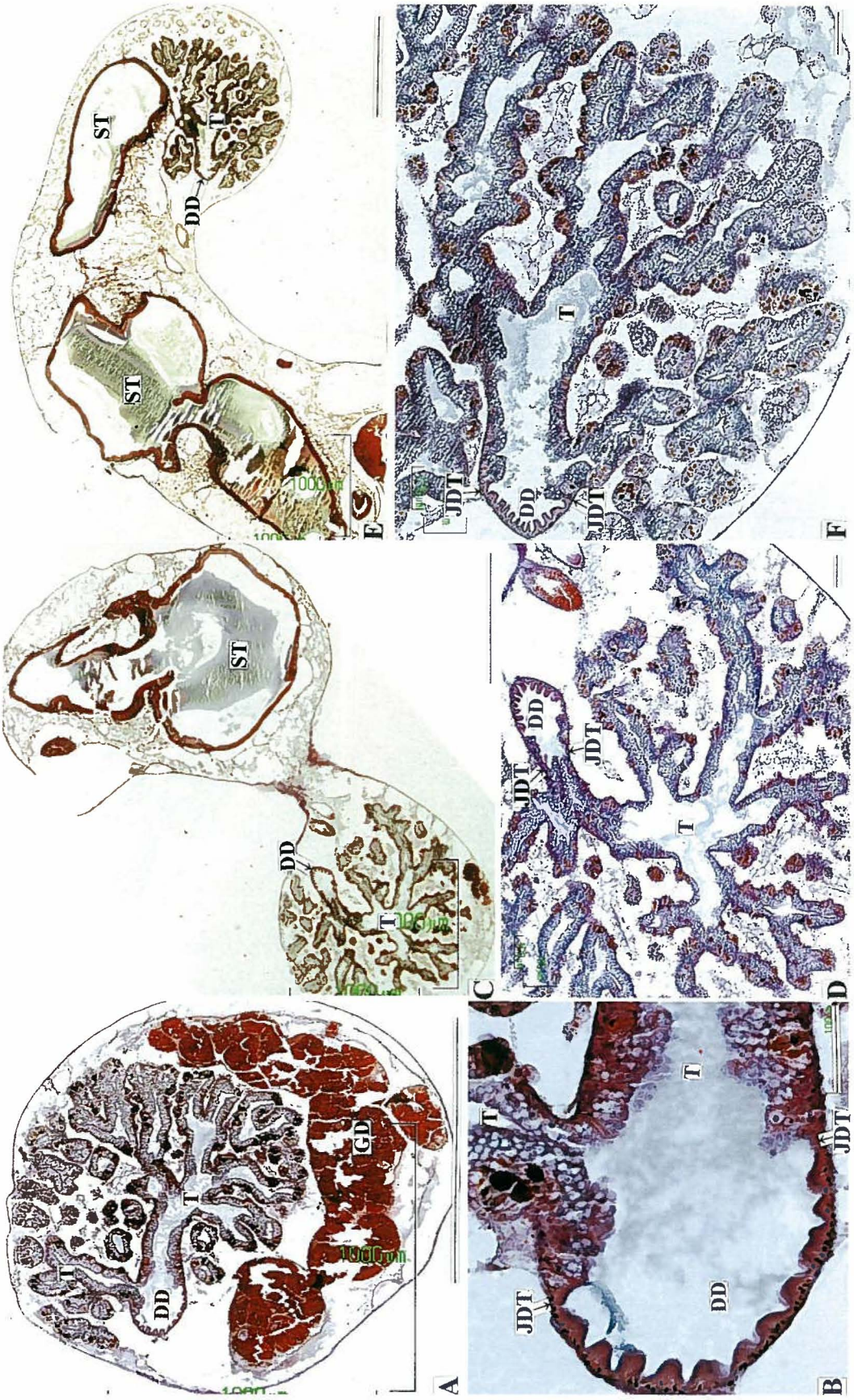

Fig. 6-2. Longitudinal sections of digestive diverticula of *Batillaria multiformis*. ST, stomach; GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, C and E = 1 mm, and bars in B, D and F = 100 μ m.

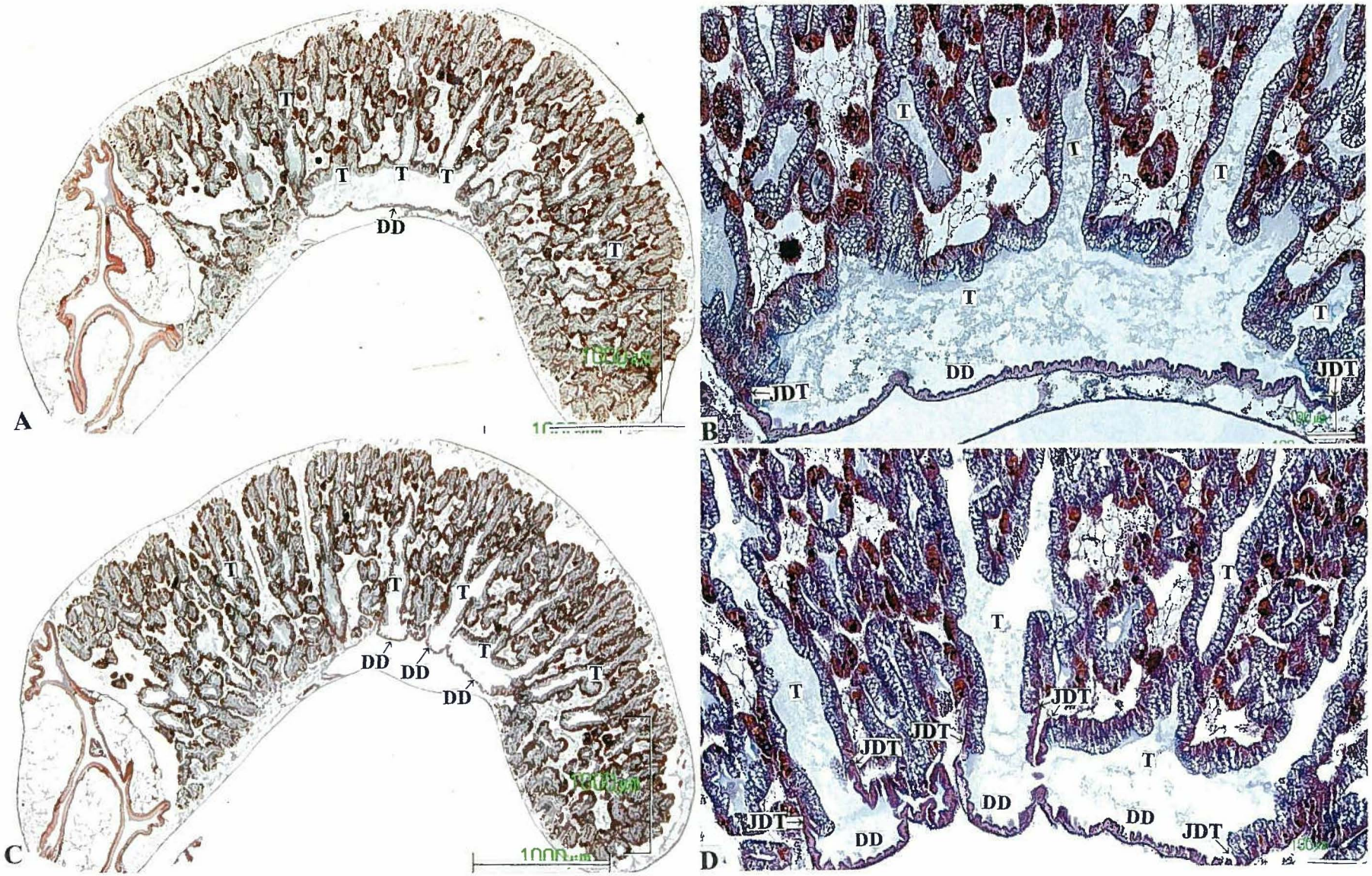

Fig. 6-3. Longitudinal sections of digestive diverticula of *Batillaria multiformis*. DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and C = 1 mm, and bars in B and D = 100 μm.

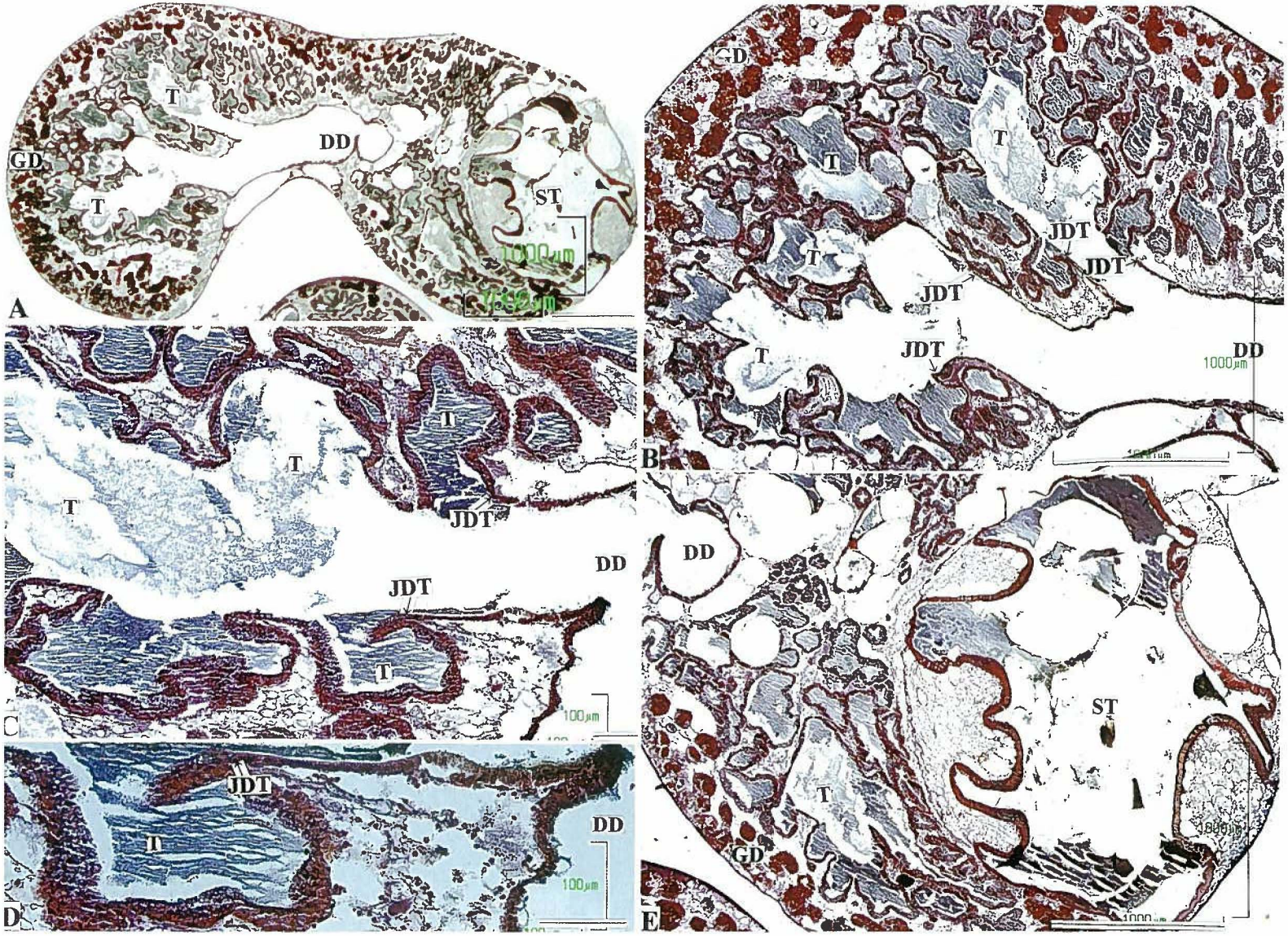

Fig. 7-1. Longitudinal sections of digestive diverticula of *Cerithidea* (*Cerithidea*) *rhizophorarum* (Discopoda: Potamididae). ST, stomach; GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, B and E = 1 mm, and bars in C and D = 100 μm.

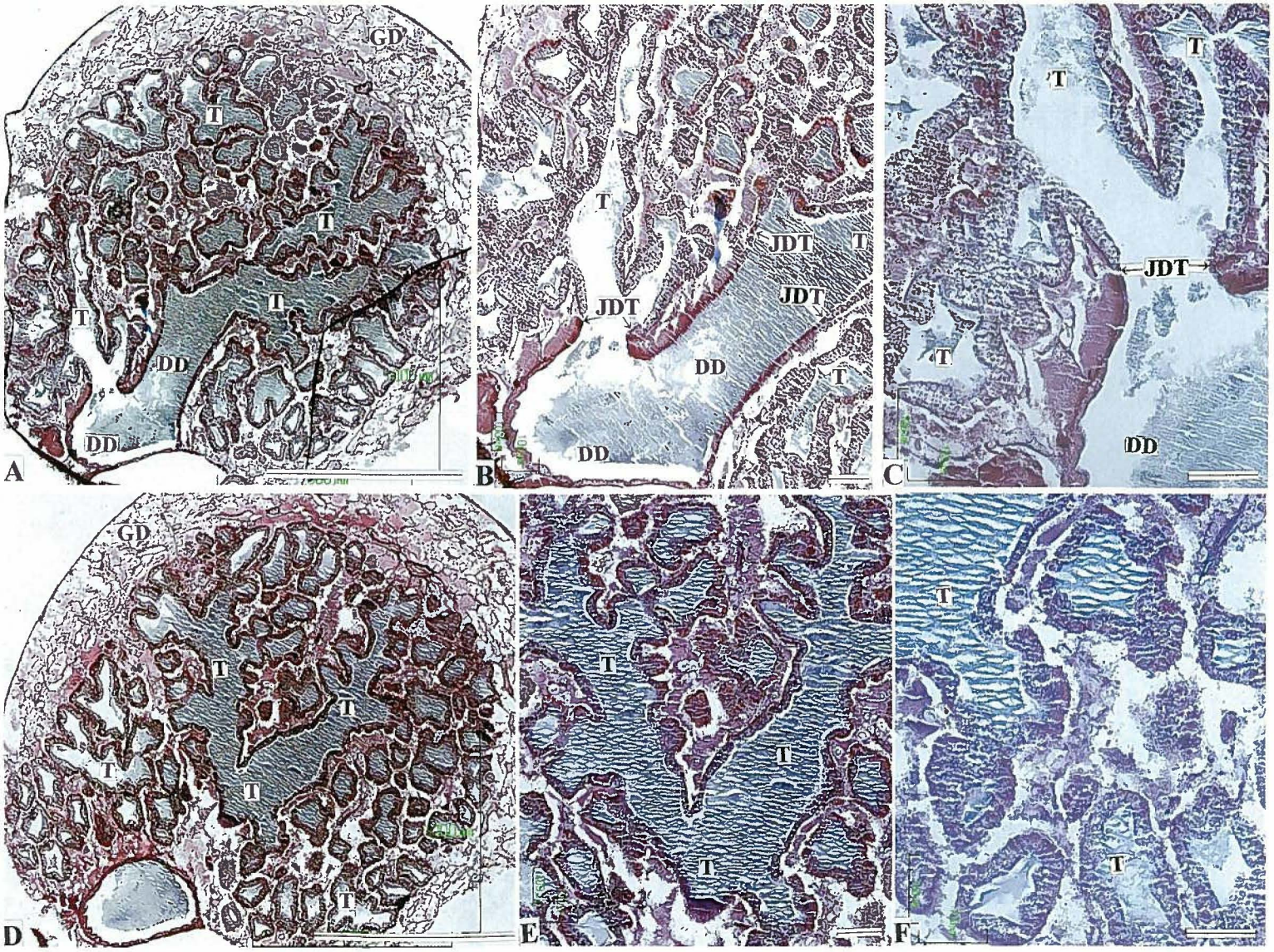

Fig. 7-2. Longitudinal sections of digestive diverticula of *Cerithidea* (*Cerithidea*) *rhizophorarum*. GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and D = 1 mm, and bars in B, C, E and F = 100 μm.

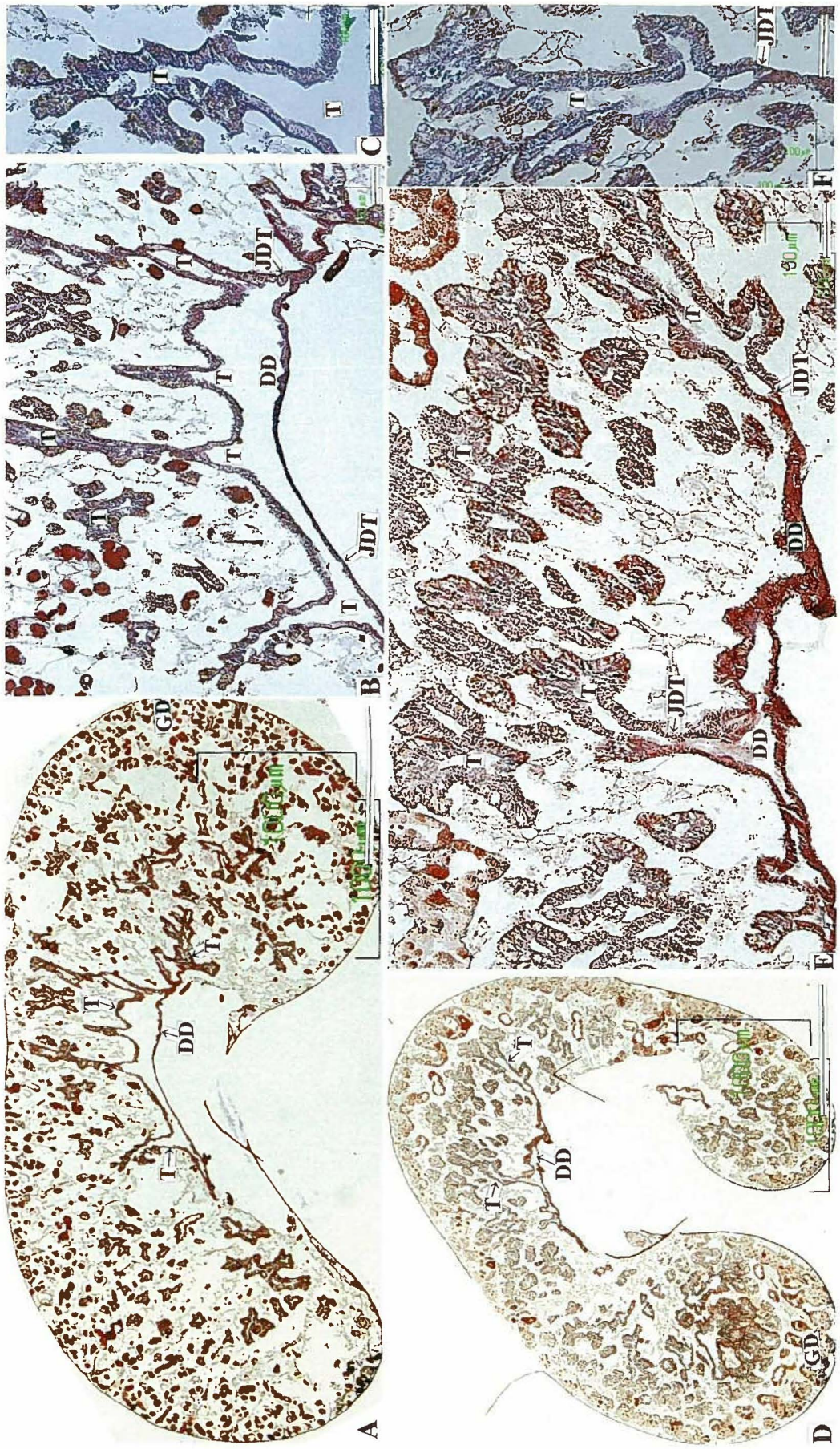

Fig. 8. Longitudinal sections of digestive diverticula of *Cerithidea* (*Cerithideopsilla*) *cingulata* (Discopoda: Potamididae). GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and D = 1 mm, and bars in B, C, E and F = 100 μ m.

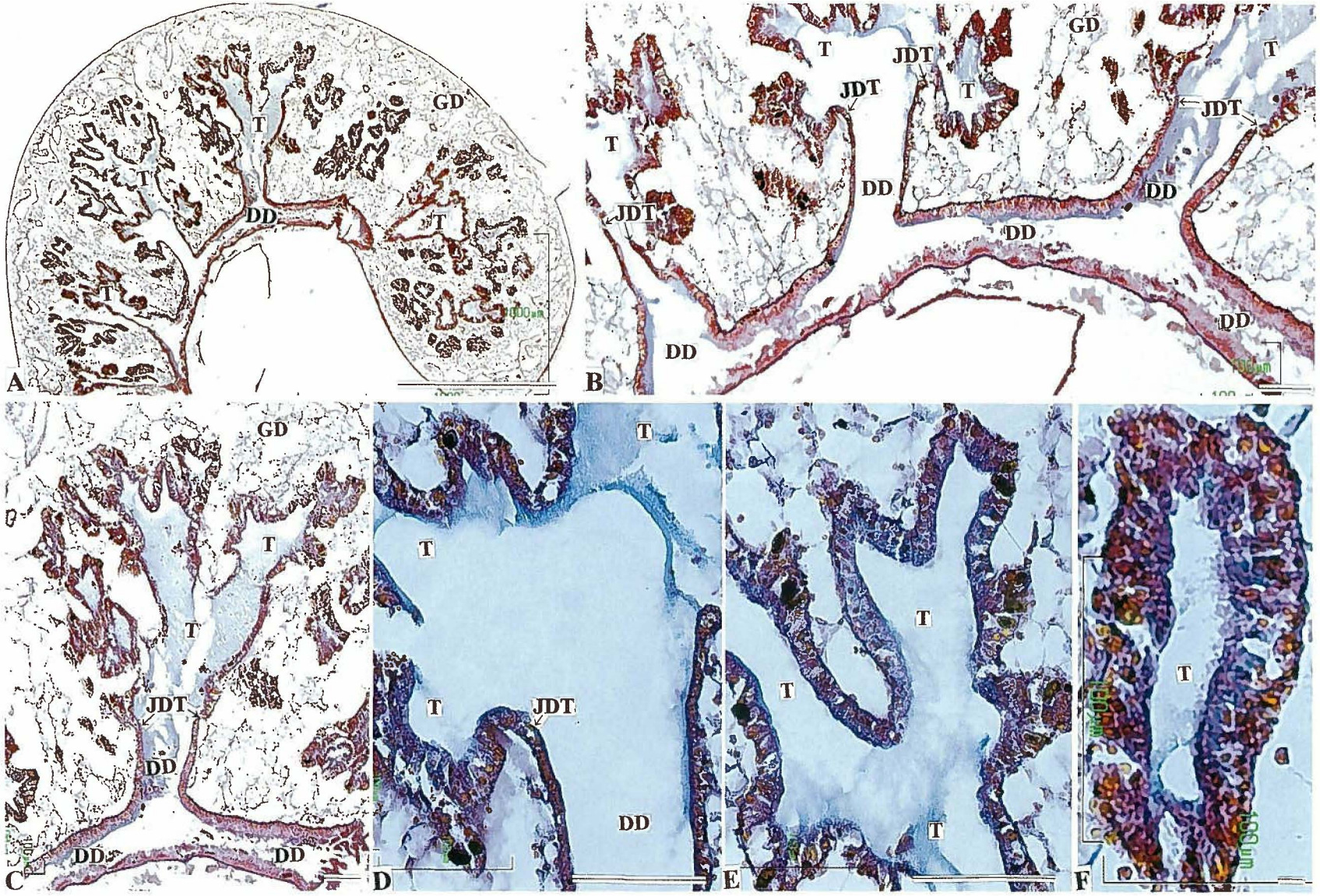

Fig. 9-1. Longitudinal sections of digestive diverticula of *Cerithidea* (*Cerithideopsilla*) *djadjariensis* (Discopoda: Potamididae). GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-F = 100 μm.

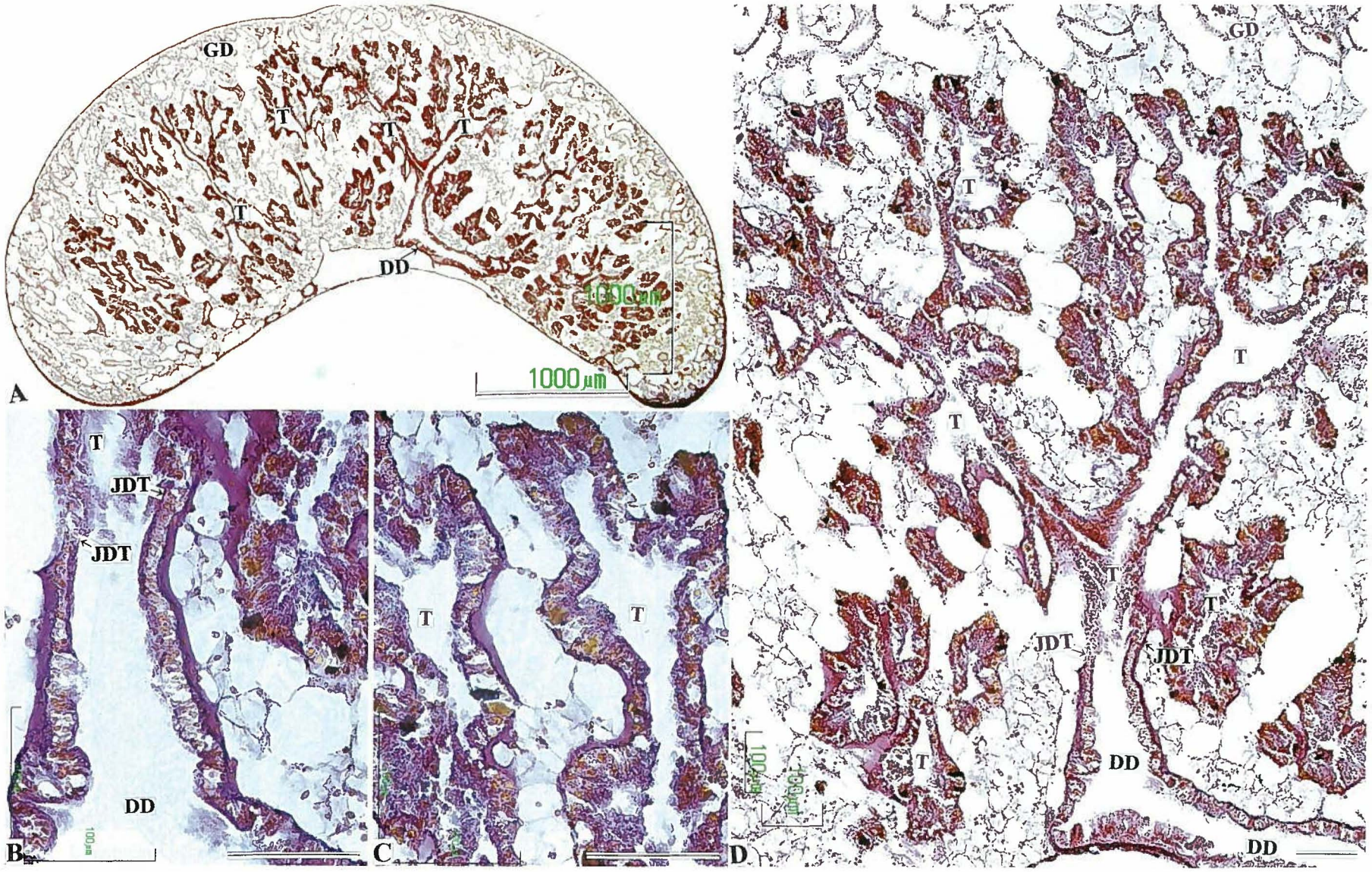

Fig. 9-2. Longitudinal sections of digestive diverticula of *Cerithidea* (*Cerithideopsilla*) *djadjariensis*. GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-D = 100 μm.

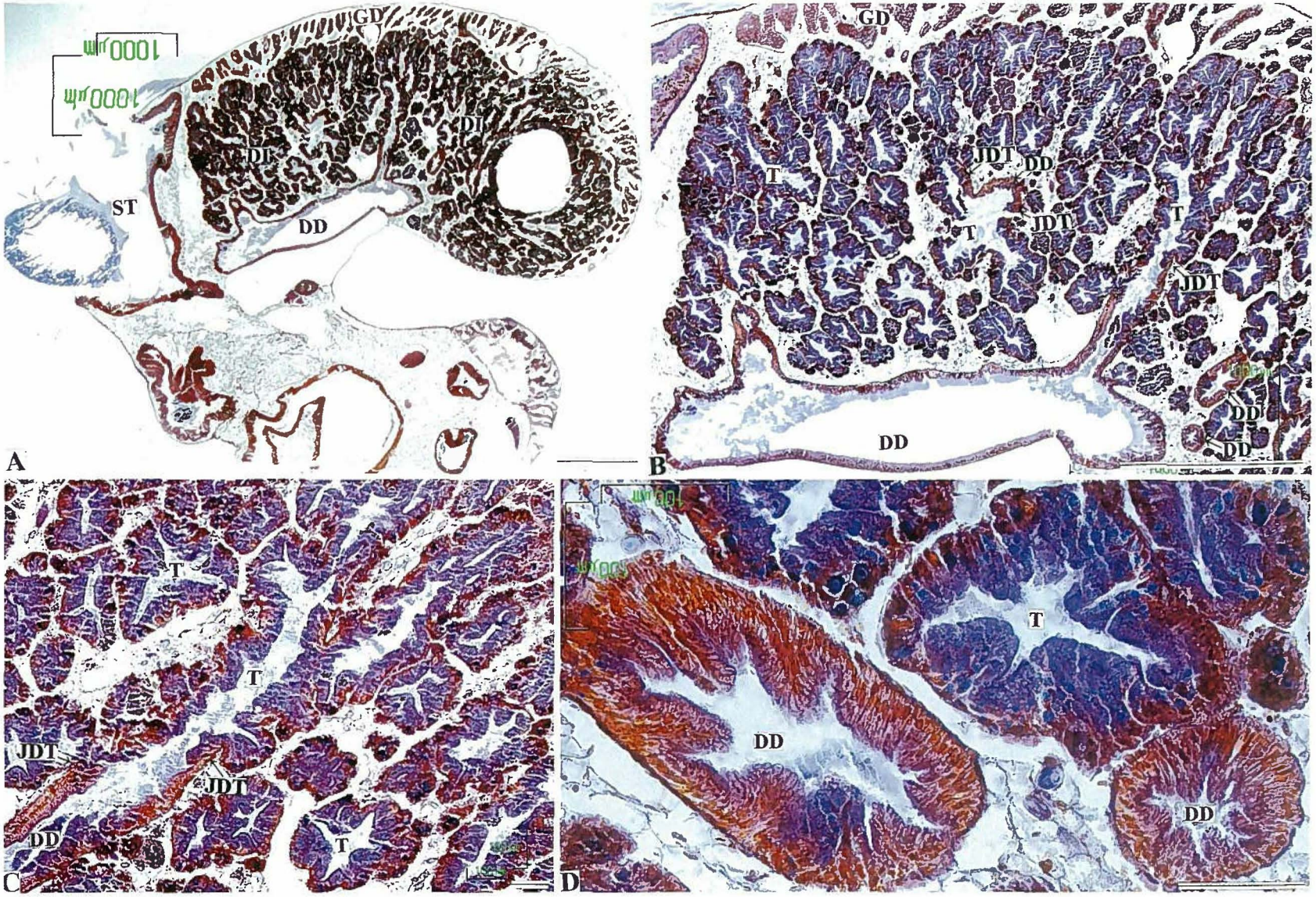

Fig. 10-1. Longitudinal sections of digestive diverticula of *Semisulcospira libertina* (Discopoda: Pleuroceridae). ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bars in C and D = 100 μm.

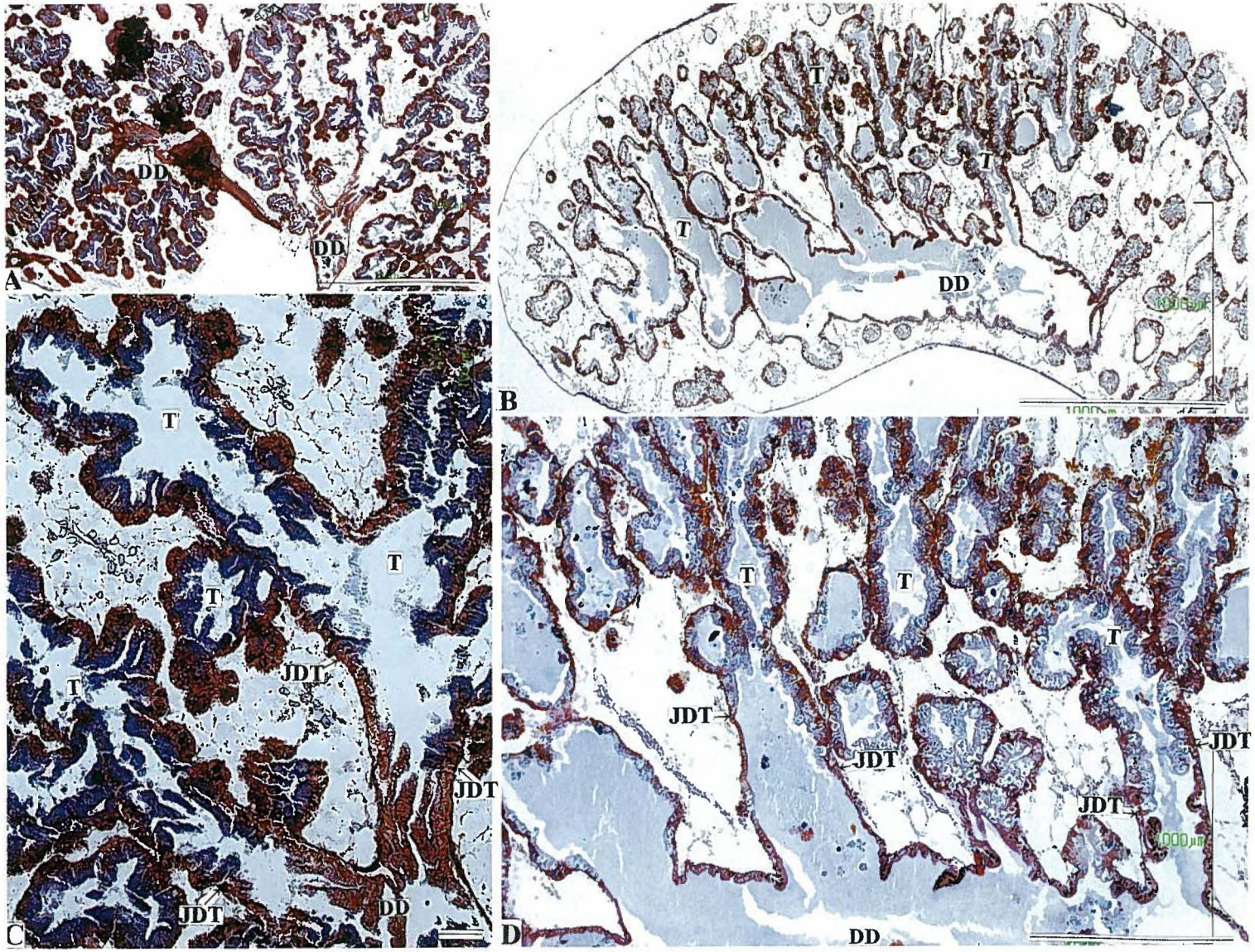

Fig. 10-2. Longitudinal sections of digestive diverticula of *Semisulcospira libertina*. DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bar in C and D = 100 μm.

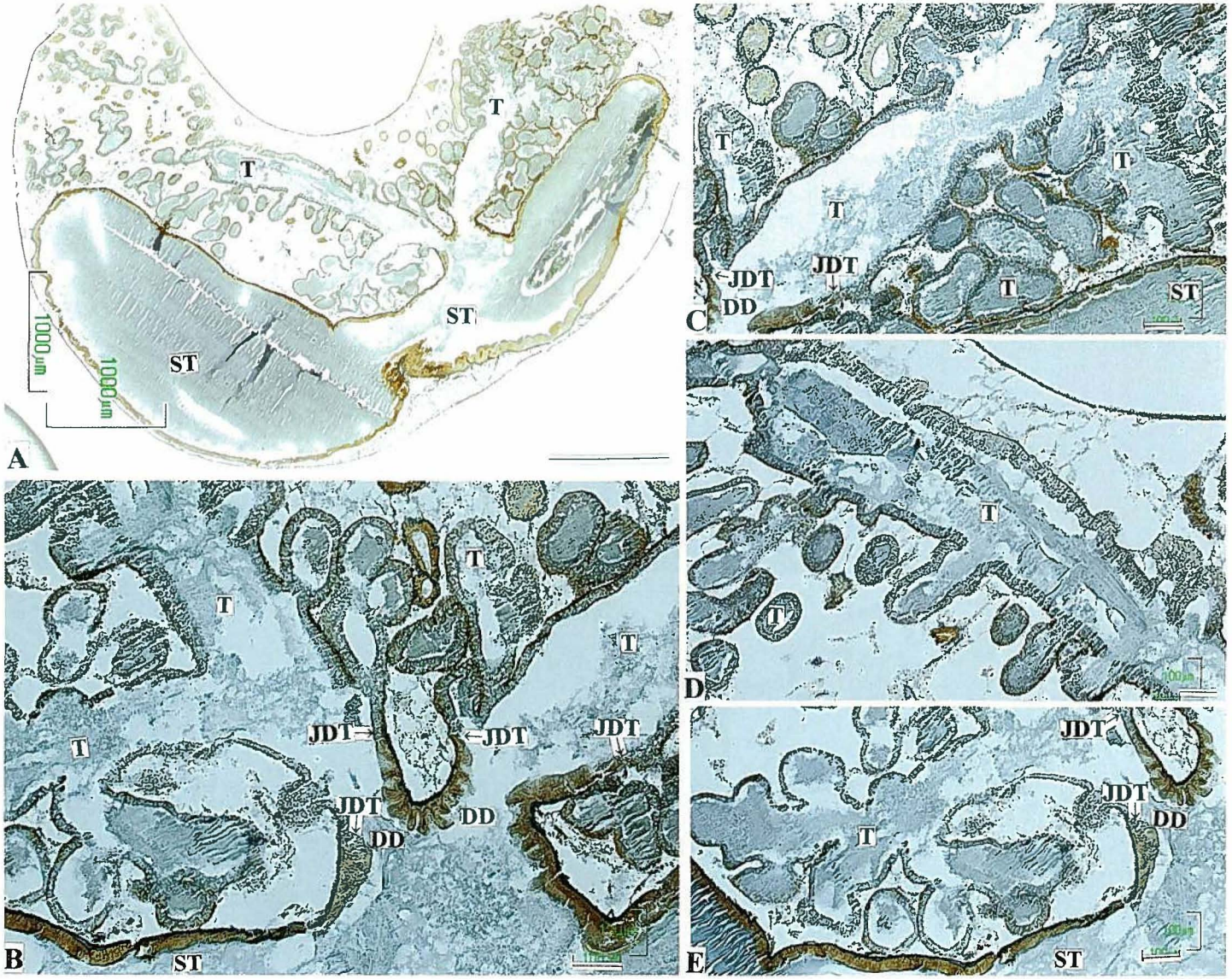

Fig. 11-1. Longitudinal sections of digestive diverticula of *Littorina* (*Littorina*) *brevicula* (Discopoda: Littorinidae). ST, stomach; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bars in B-E = 100 μm.

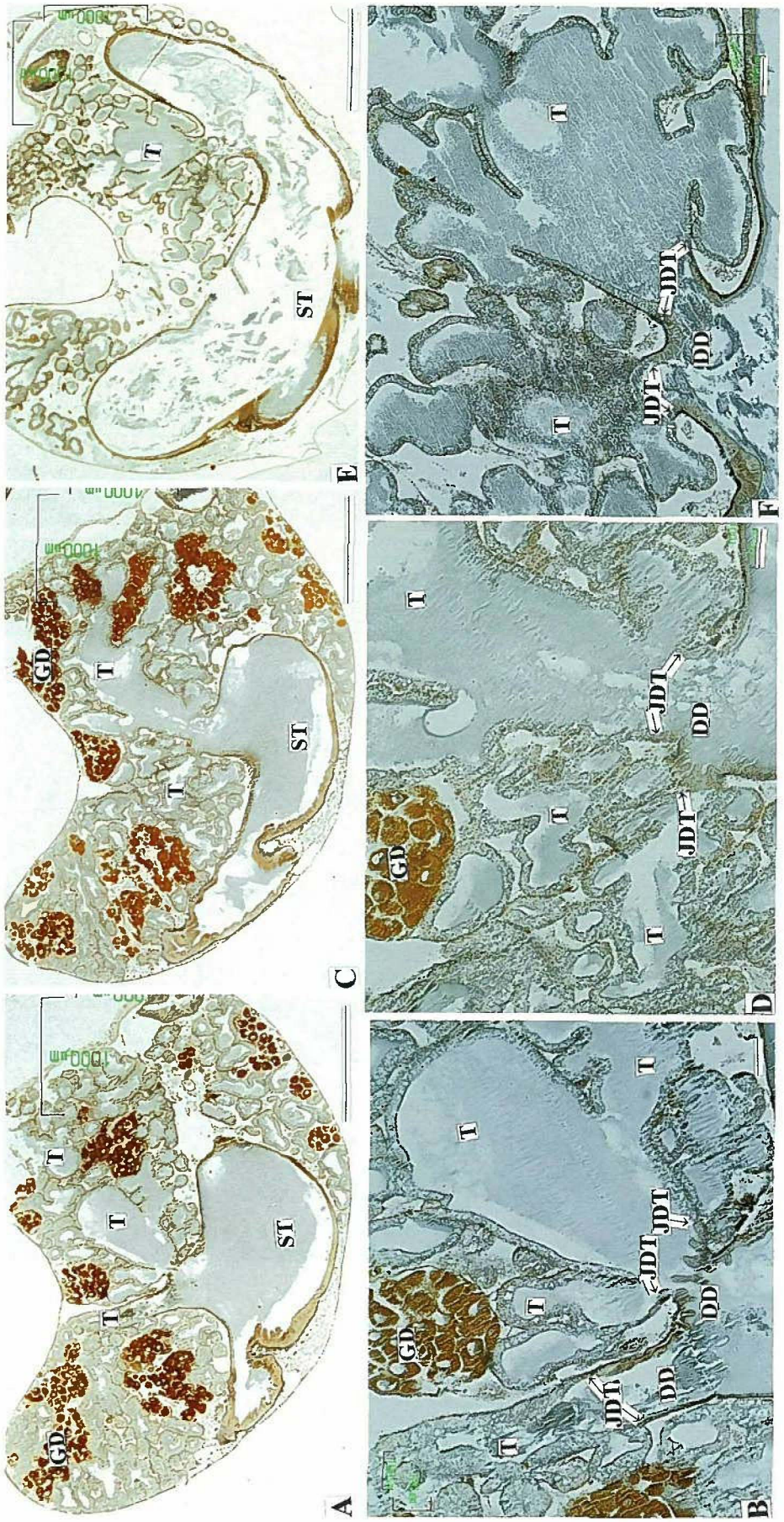

Fig. 11-2. Longitudinal sections of digestive diverticula of *Littorina* (*Littorina*) *brevicula* . ST, stomach; GD, gonad; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, C and E = 1 mm, and bars in B, D and F = 100 μ m.

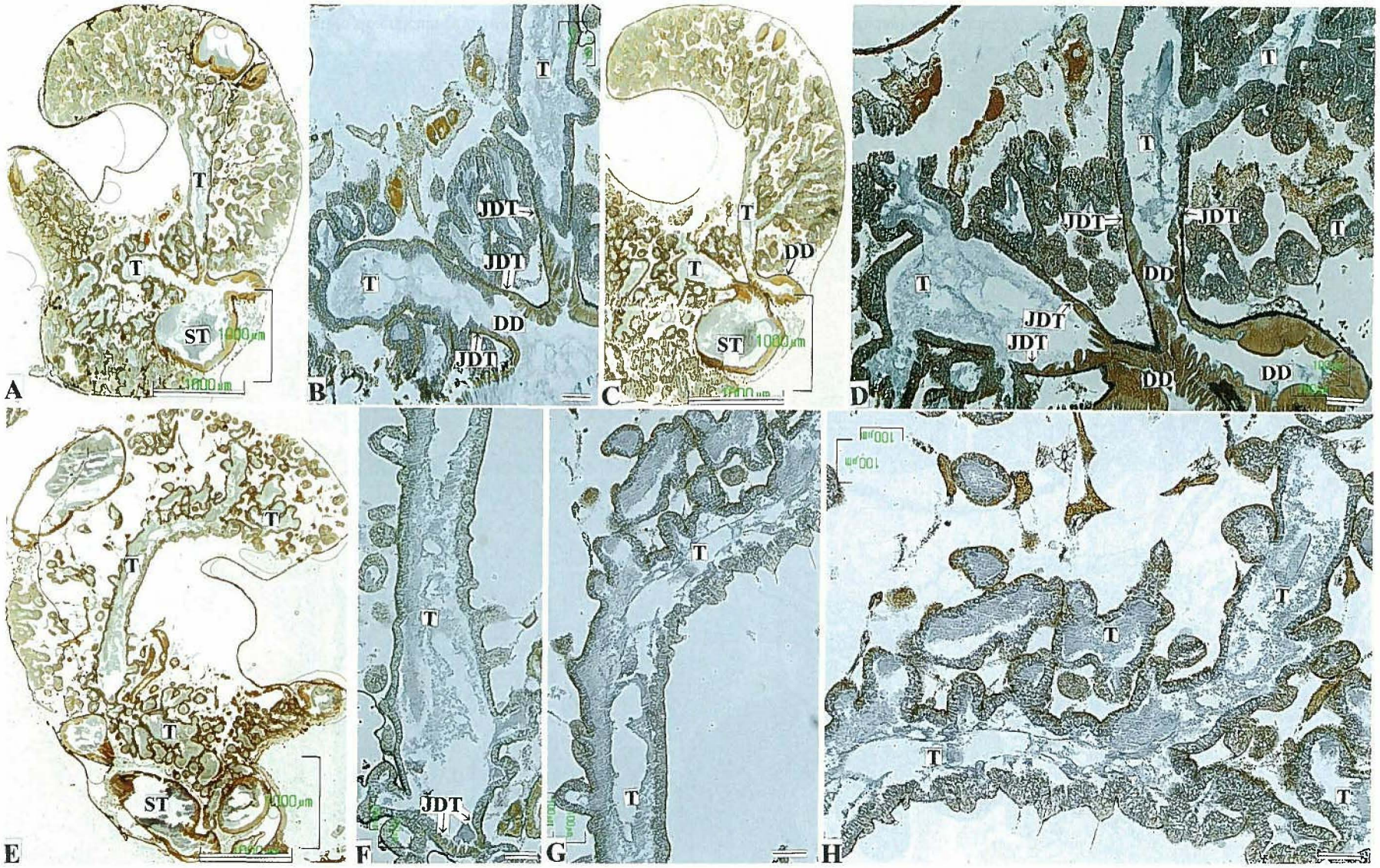

Fig. 11-3. Longitudinal sections of digestive diverticula of *Littorina* (*Littorina*) *brevicula* . ST, stomach; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, C and E = 1 mm, and bars in B, D, F, G and H = 100 μ m.

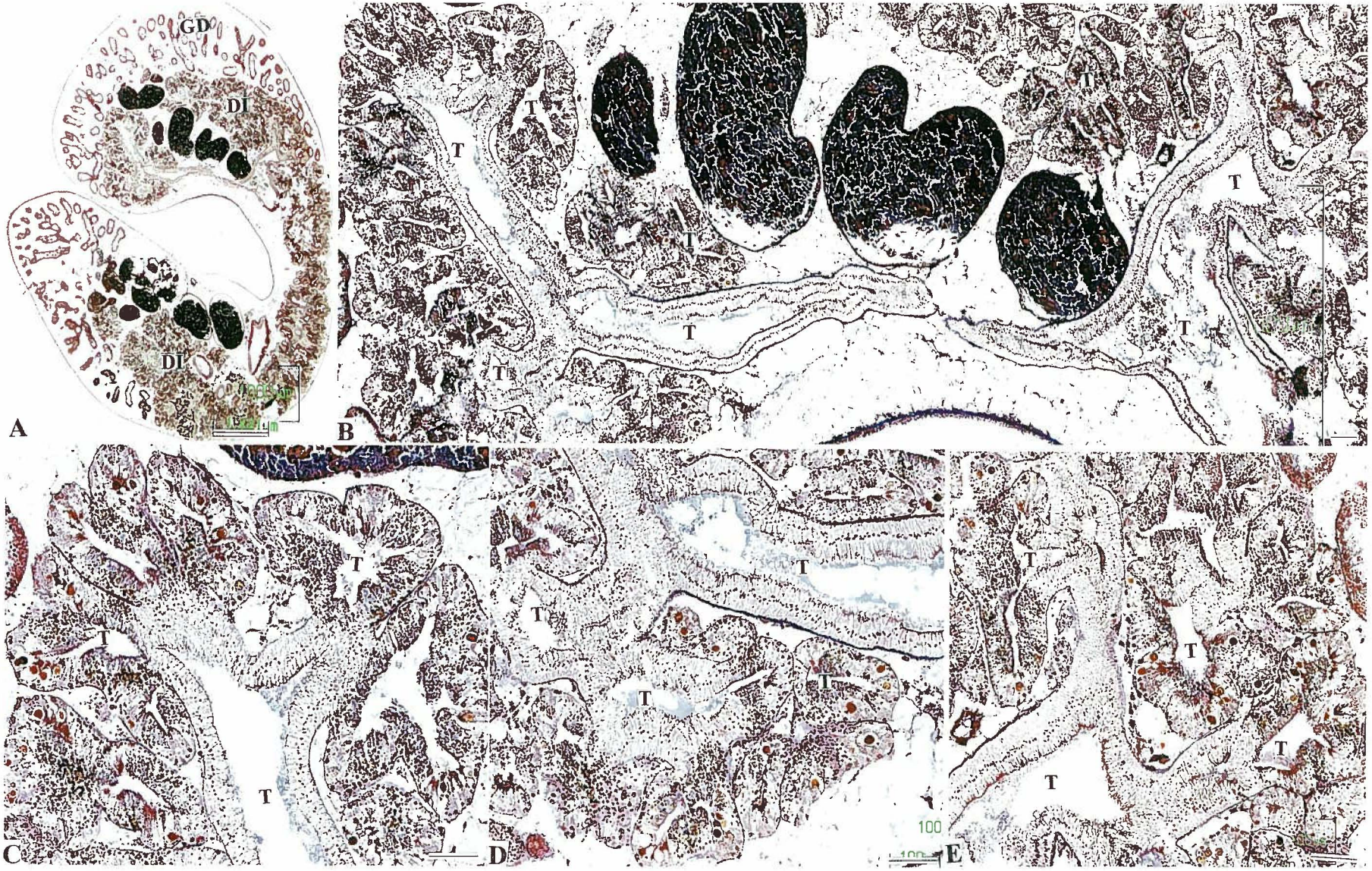

Fig. 12-1. Longitudinal sections of digestive diverticula of *Strombus* (*Doxander*) *Japonicus* (Discopoda: Strombidae). GD, gonad; DI, digestive diverticula; T, tubule. Azan staining. Bar in A = 1 mm, and bars in B-E = 100 μm.

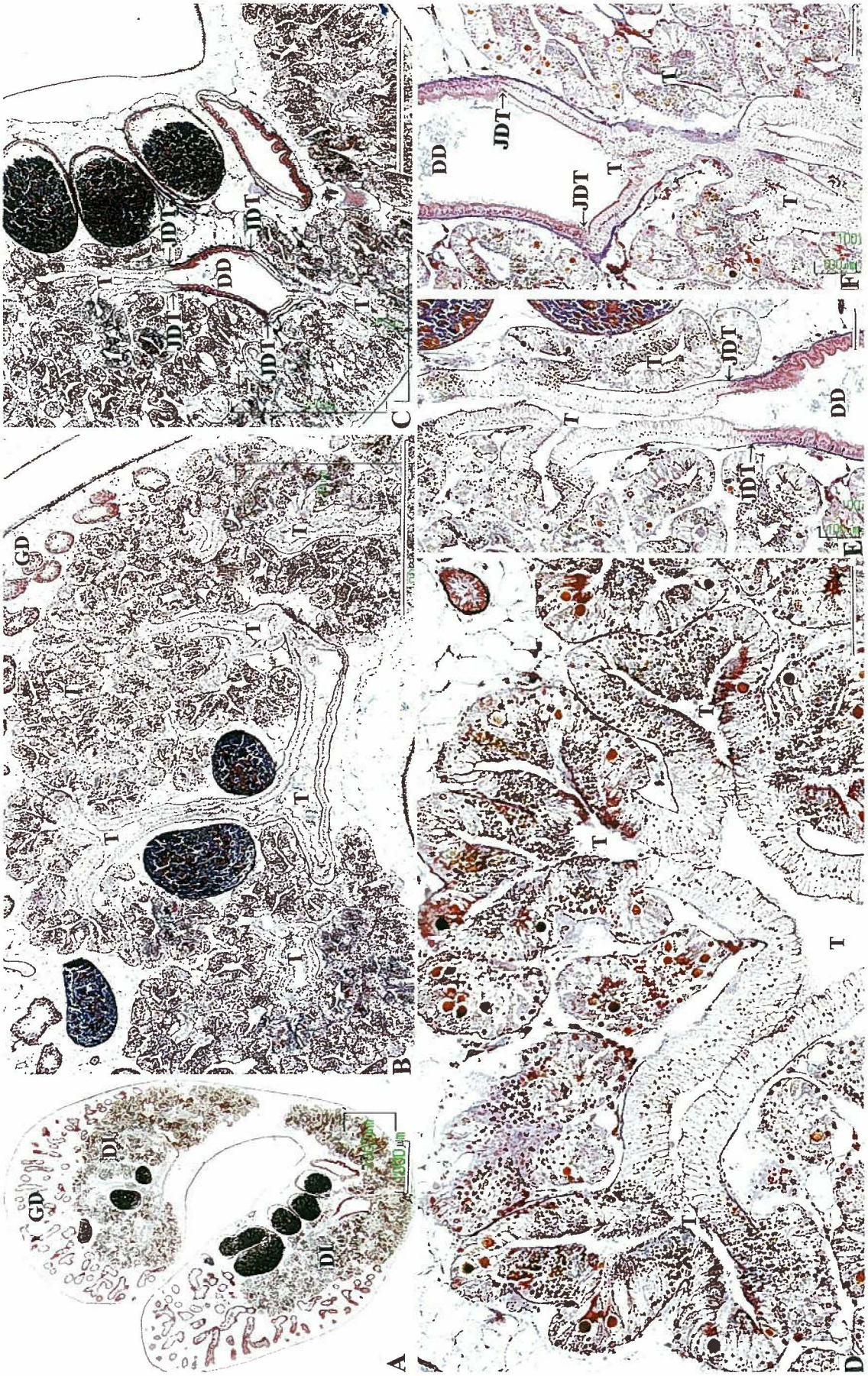

Fig. 12-2. Longitudinal sections of digestive diverticula of *Strombus* (*Doxander*) *Japonicus*. GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A-C = 1 mm, and bars in D-F = 100 μm.

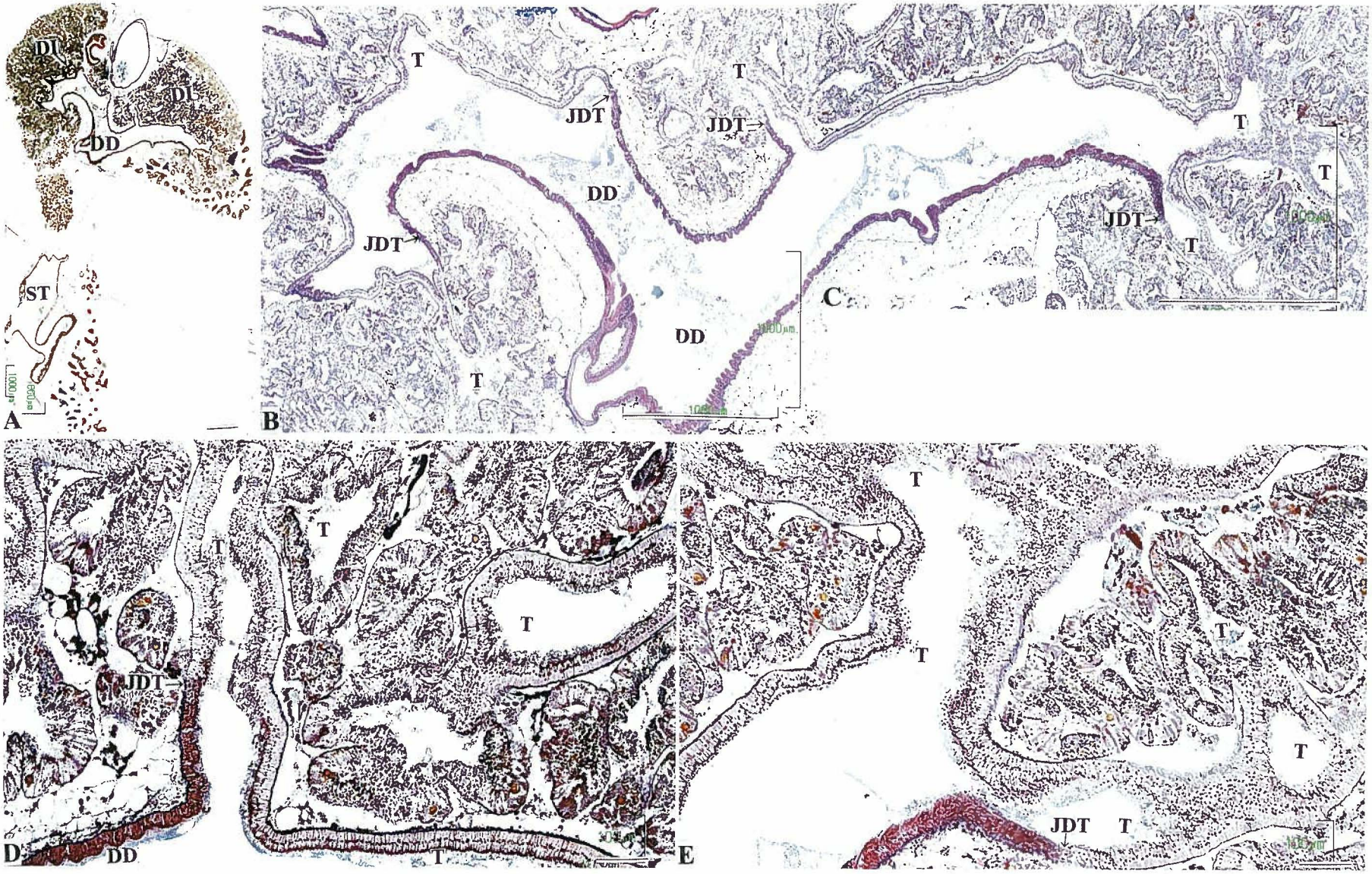

Fig. 12-3. Longitudinal sections of digestive diverticula of *Strombus* (*Doxander*) *Japonicus*. ST, stomach; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A-C = 1 mm, and bars in D and E = 100 μm.

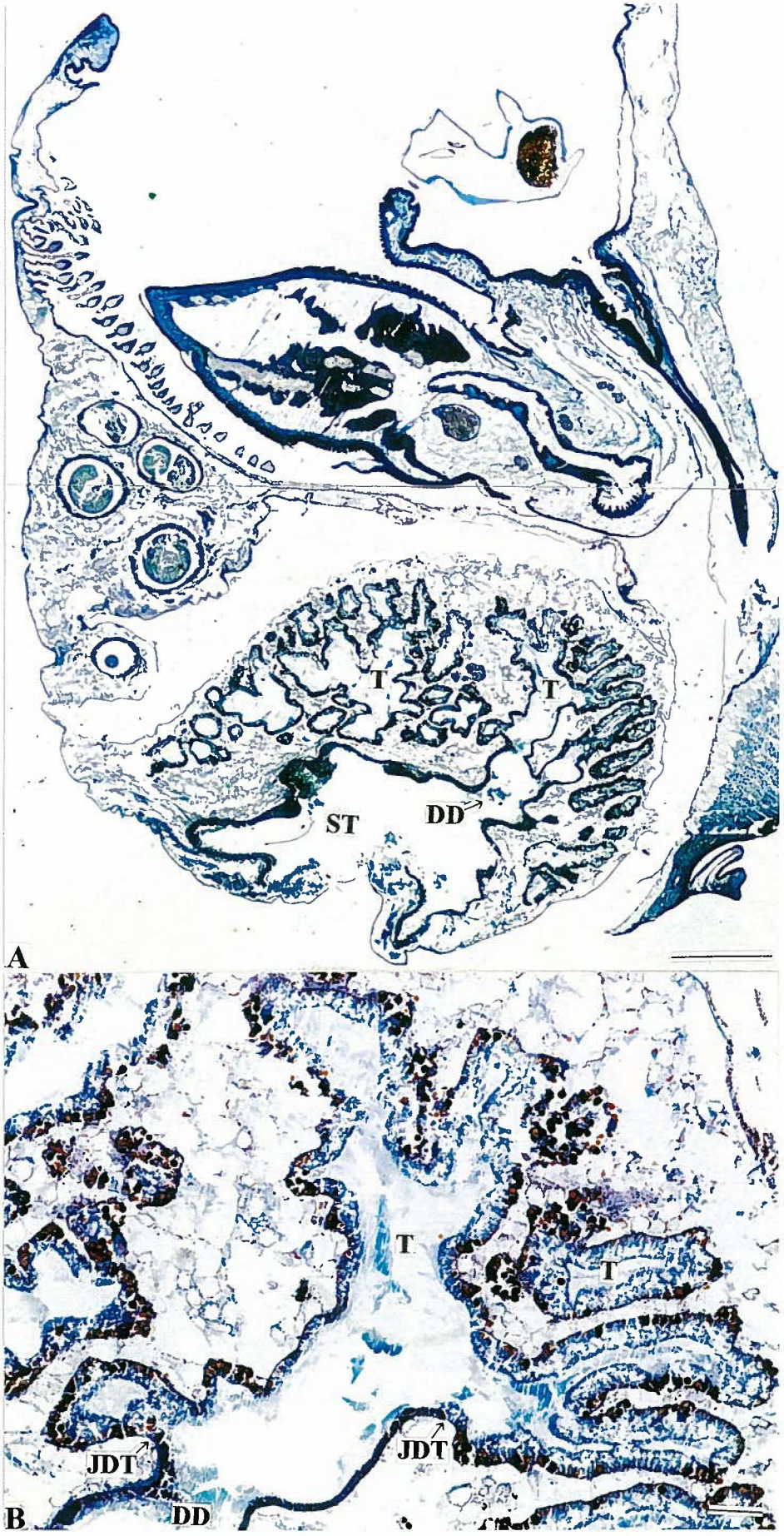

Fig. 13-1. Vertical sections of digestive diverticula of *Hipponix conica* (Discopoda: Hipponicidae). ST, stomach; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bar in A = 1 mm, and bar in B = 100 μm.

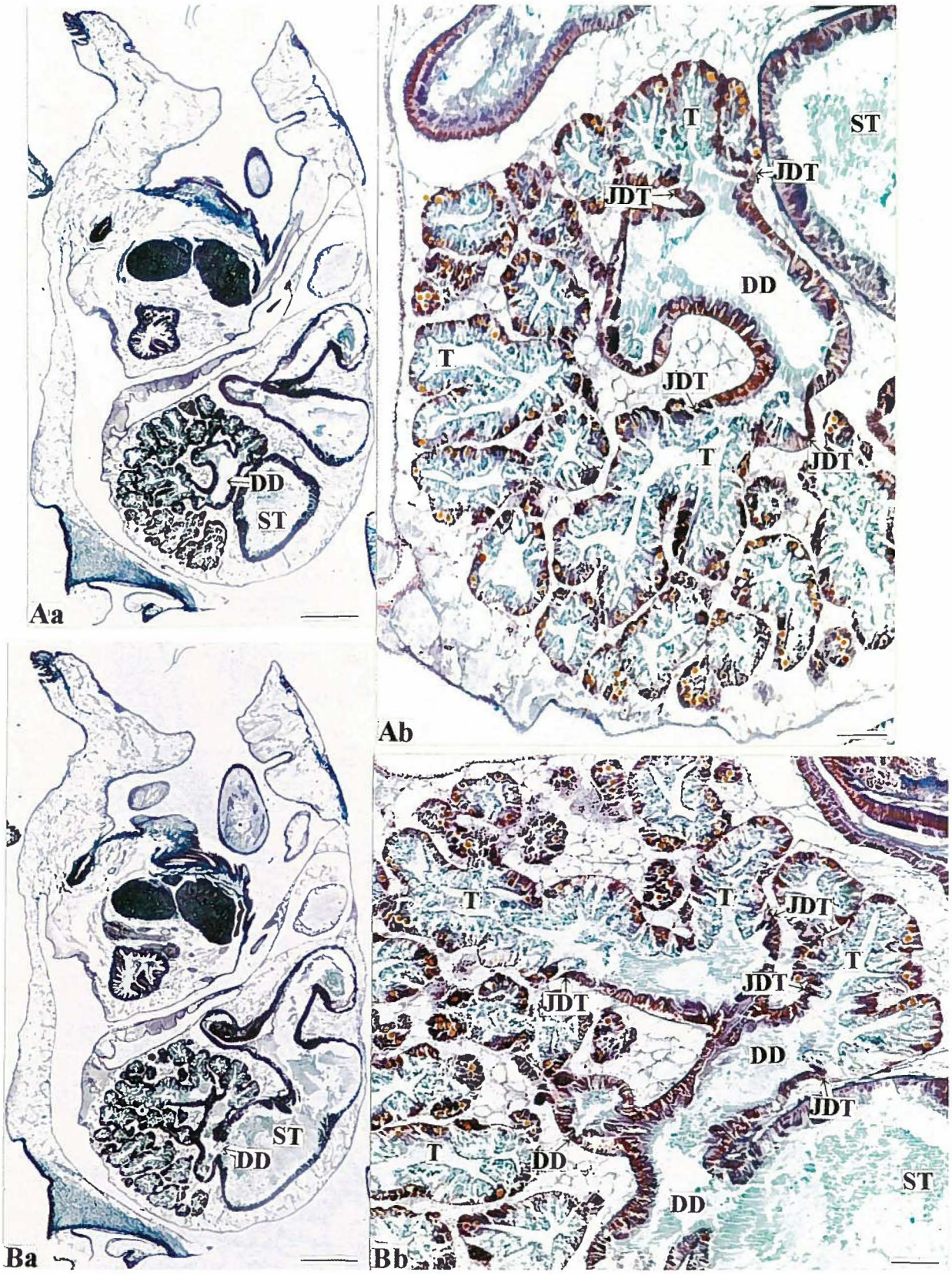

Fig. 13-2. Vertical sections of digestive diverticula of *Hipponix conica*. ST, stomach; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in Aa and Ba = 1 mm, and bars in Ab and Bb = 100 μm.

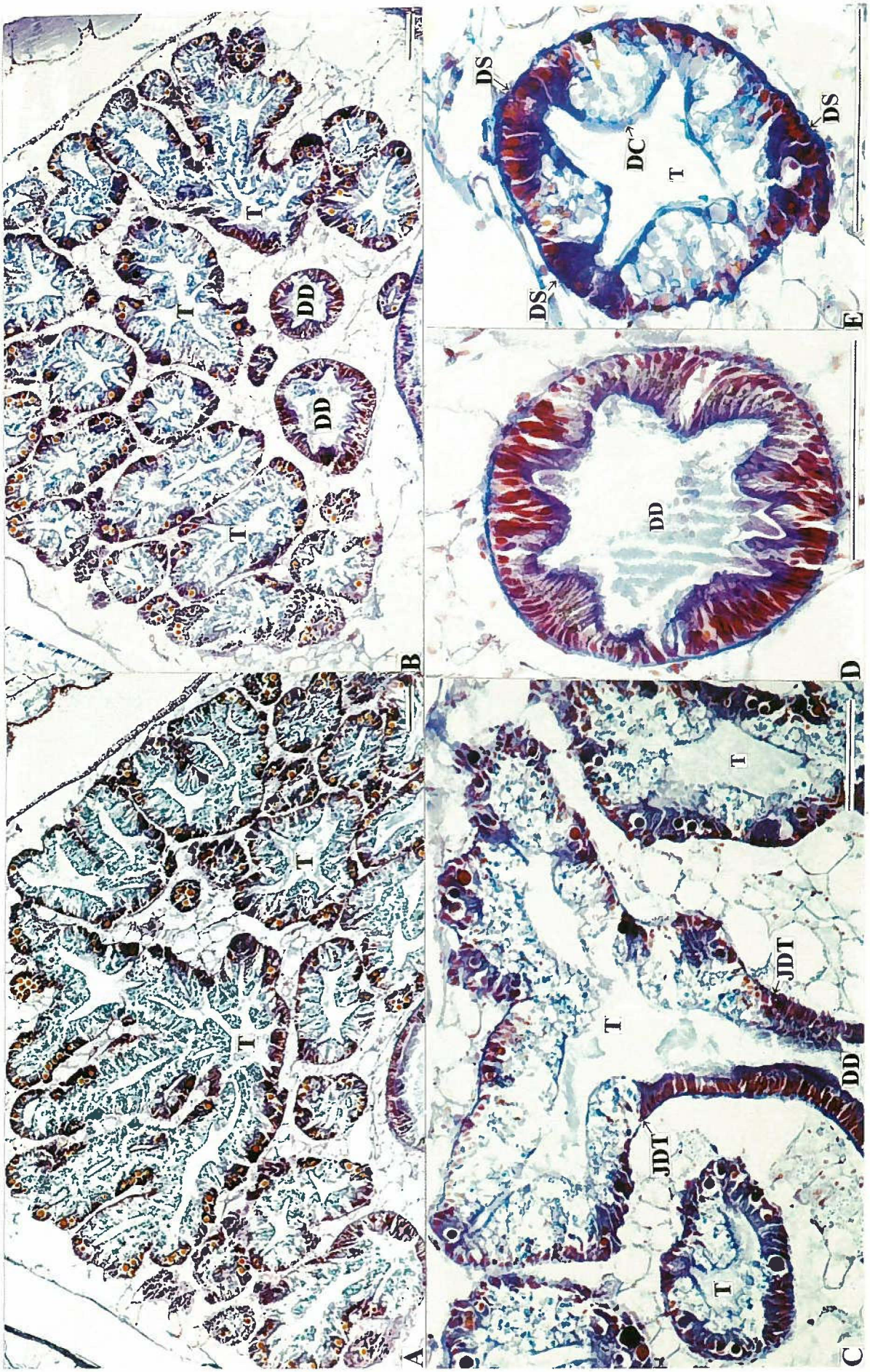

Fig. 13-3. Vertical sections of digestive diverticula of *Hipponix conica*. DD, duct; T, tubule; JDT, junction of the duct with a tubule, DC, digestive cell; DS, darkly staining cell. Azan stain. Bars = 100 μ m.

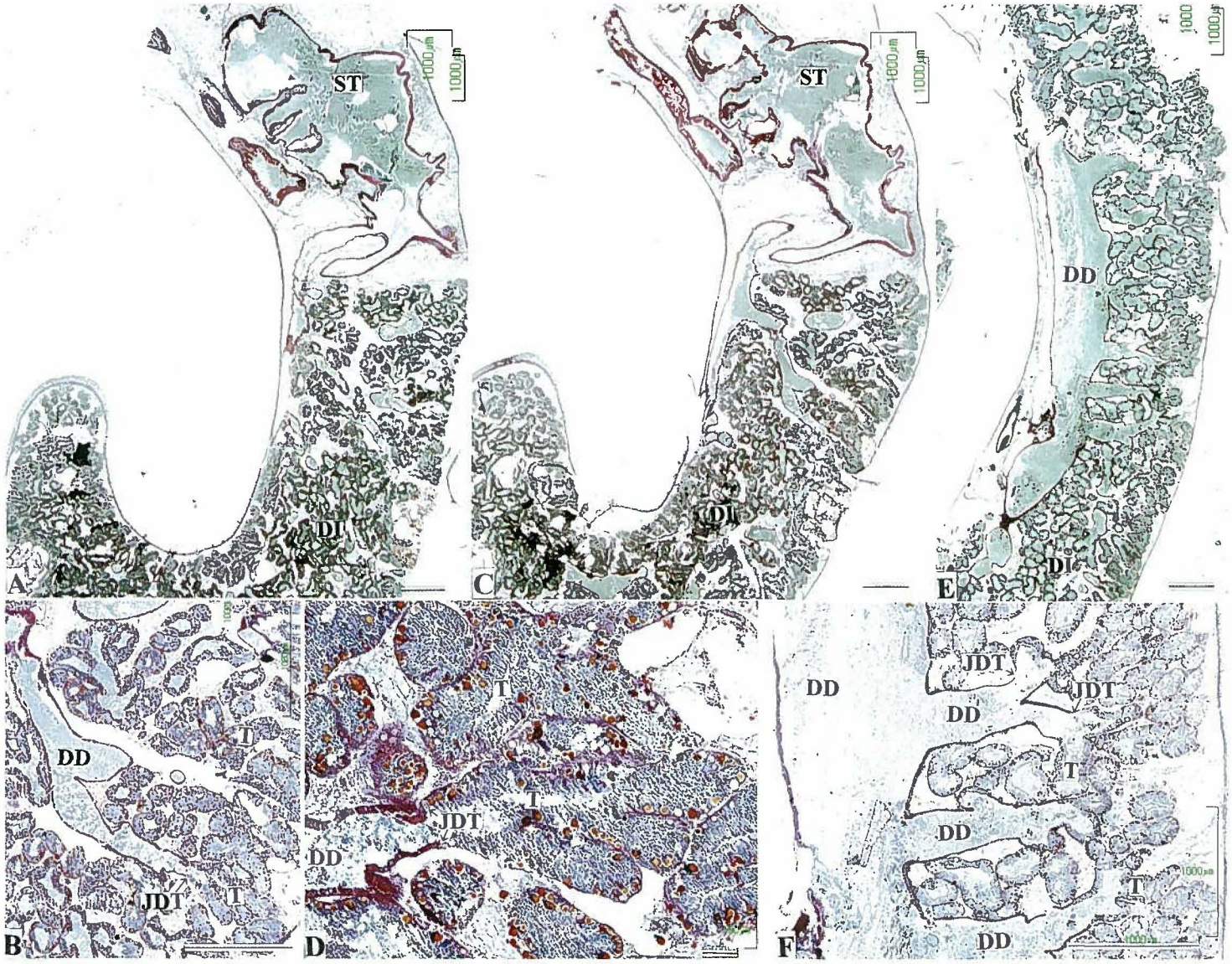

Fig. 14-1. Longitudinal sections of digestive diverticula of *Serpulorbis imbricatus* (Discopoda: Vermetidae). ST, stomach; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, C and E = 1 mm, and bars in B, D and F = 100 μm.

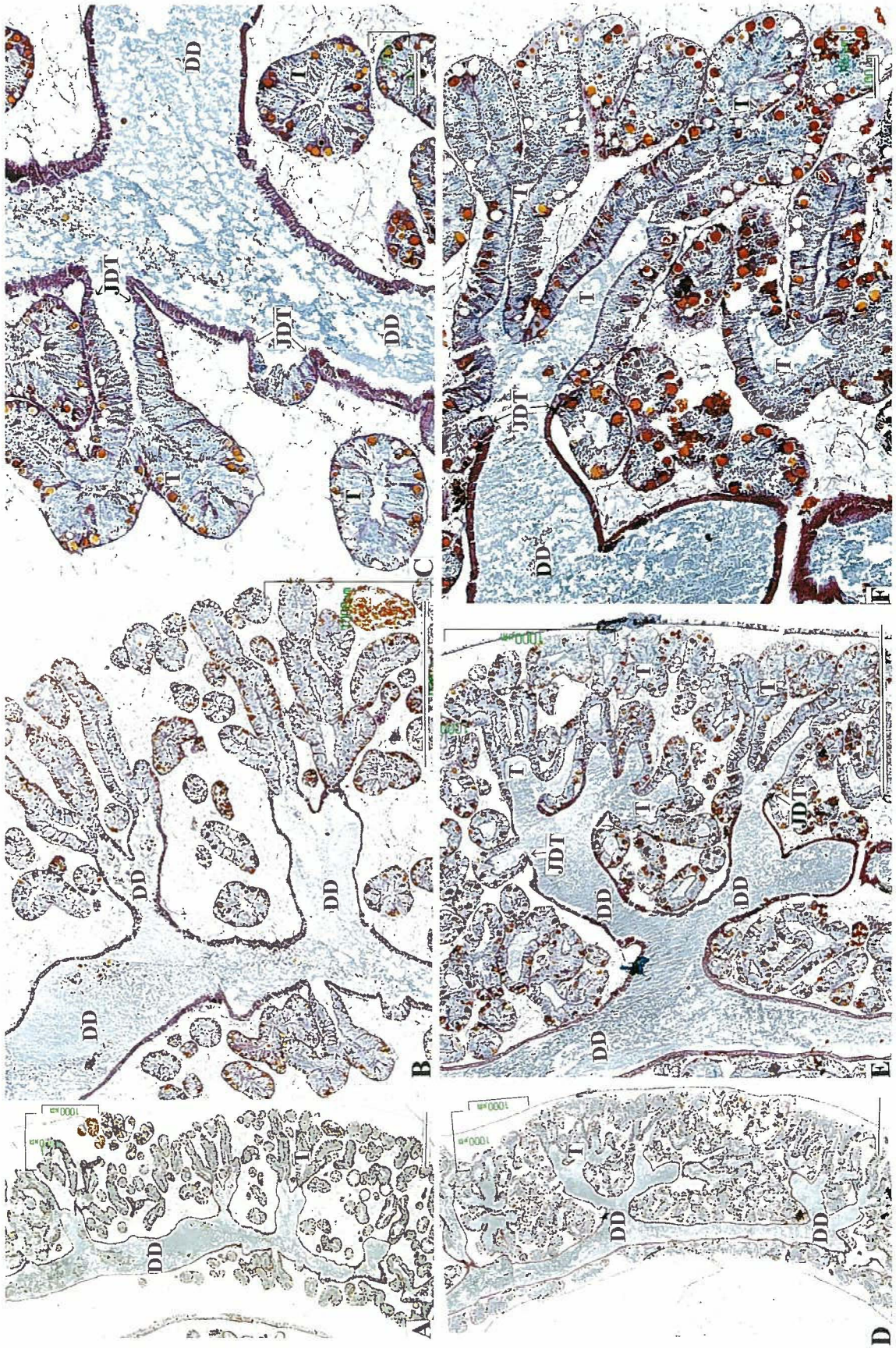

Fig. 14-2. Longitudinal sections of digestive diverticula of *Serpulorbis imbricatus*. DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, B, D and E = 1 mm, and bars in C and F = 100 μm.

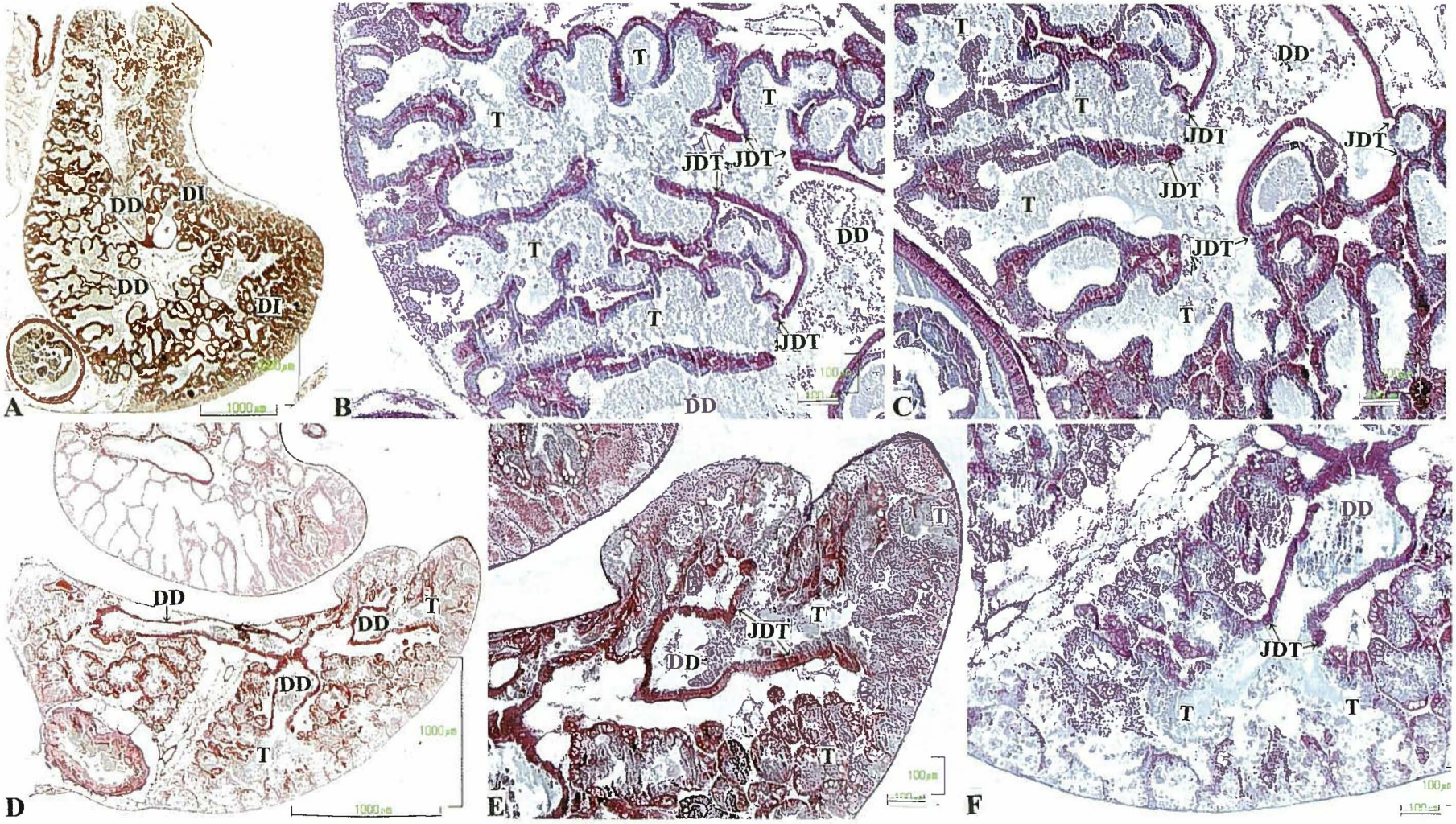

Fig. 15-1. Longitudinal sections of digestive diverticula of *Cypraea* (*Purpuradusta*) *gracilis* (Discopoda: Cypraeidae). DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and D = 1 mm, and bars in B, C, E and F = 100 μm.

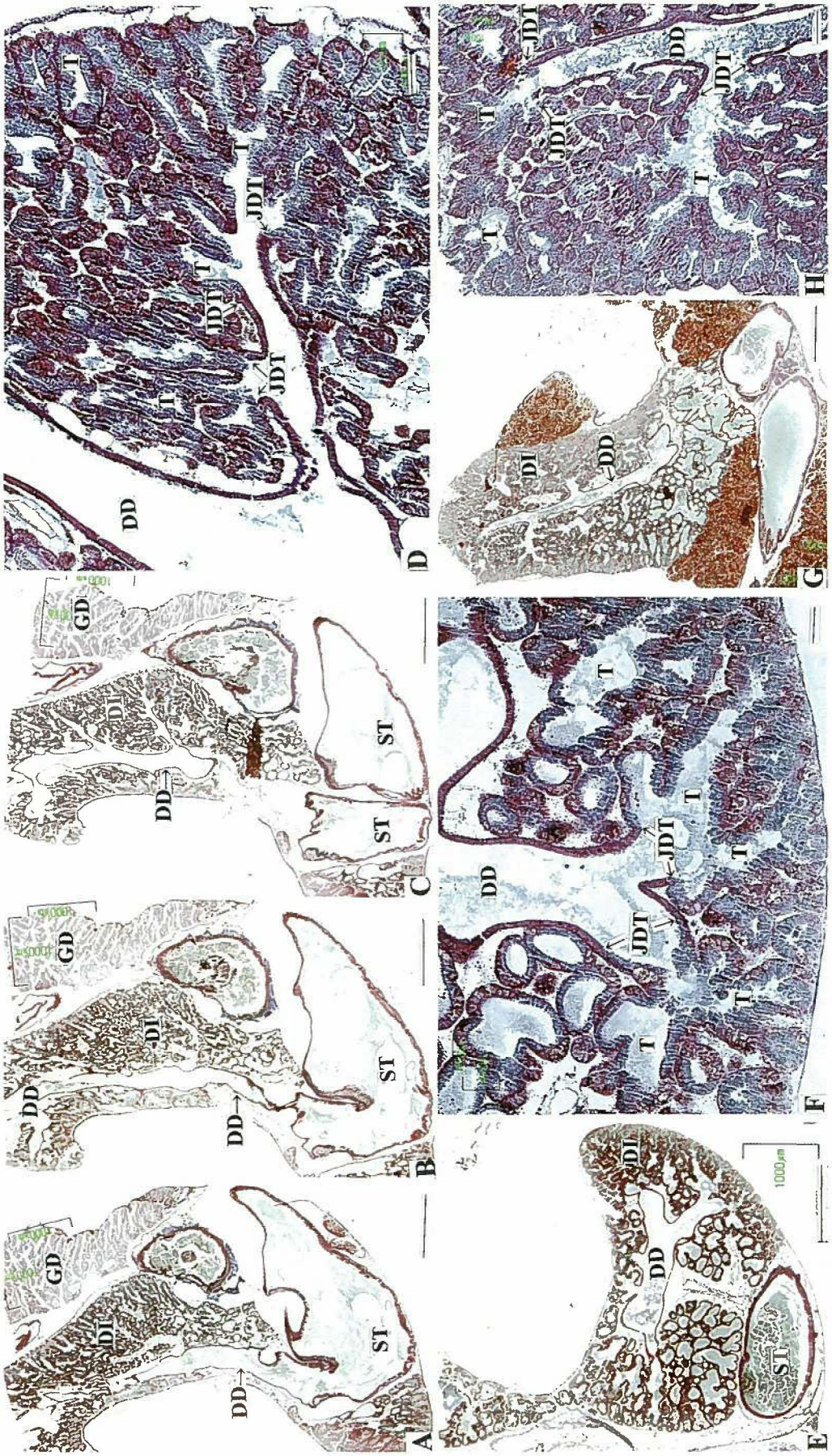

Fig. 15-2. Longitudinal sections of digestive diverticula of *Cypraea* (*Purpuradusta*) *gracilis*. ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A, B, C and E = 1 mm, and bars in D, F, G and H = 100 μm.

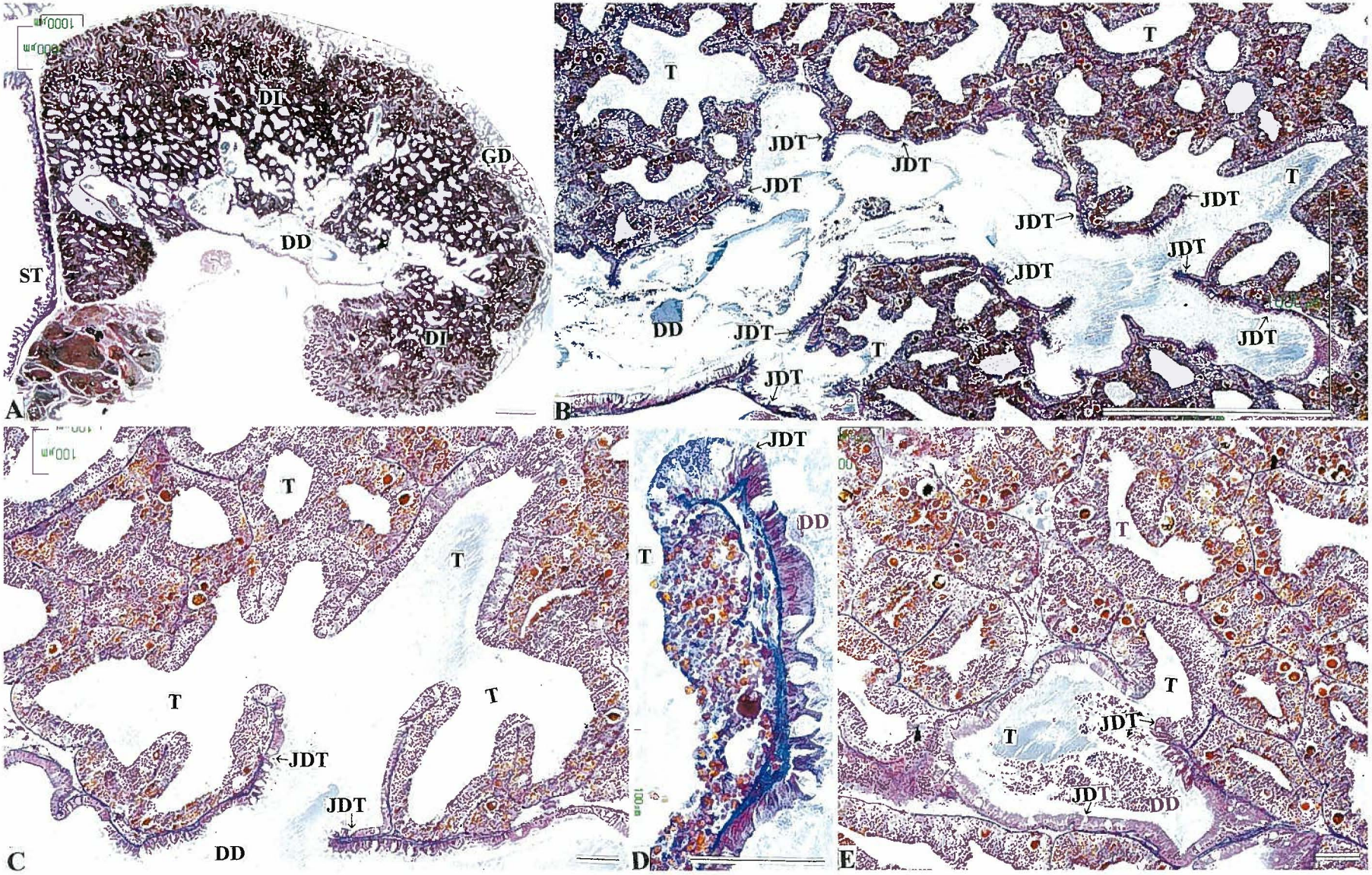

Fig. 16-1. Longitudinal sections of digestive diverticula of *Bufonaria rana* (Discopoda: Bursidae). ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bars in C-E = 100 μm.

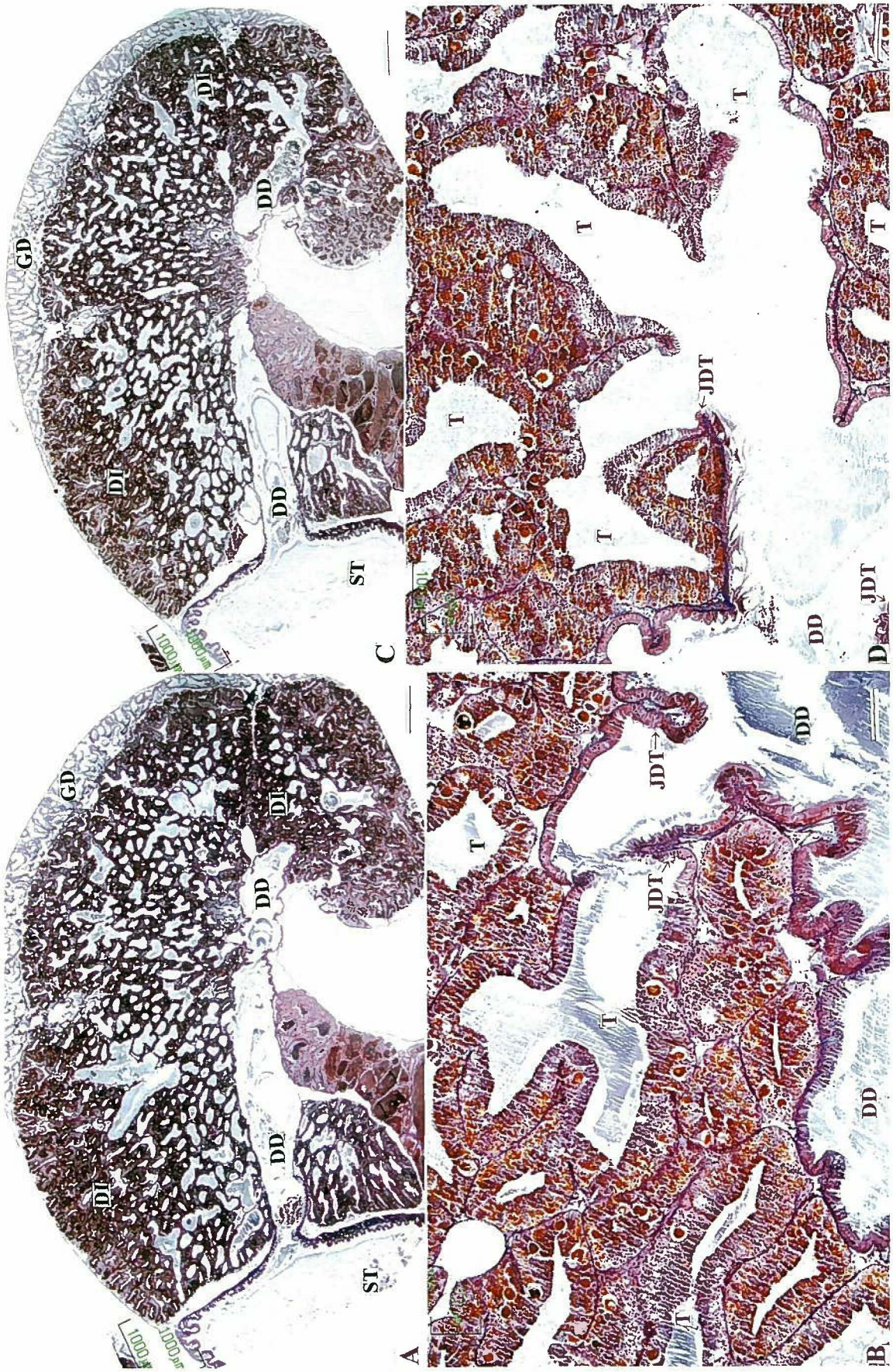

Fig. 16-2. Longitudinal sections of digestive diverticula of *Bufonaria rana*. ST, stomach; GD, gonad; DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and C = 1 mm, and bars in B and D = 100 μm.

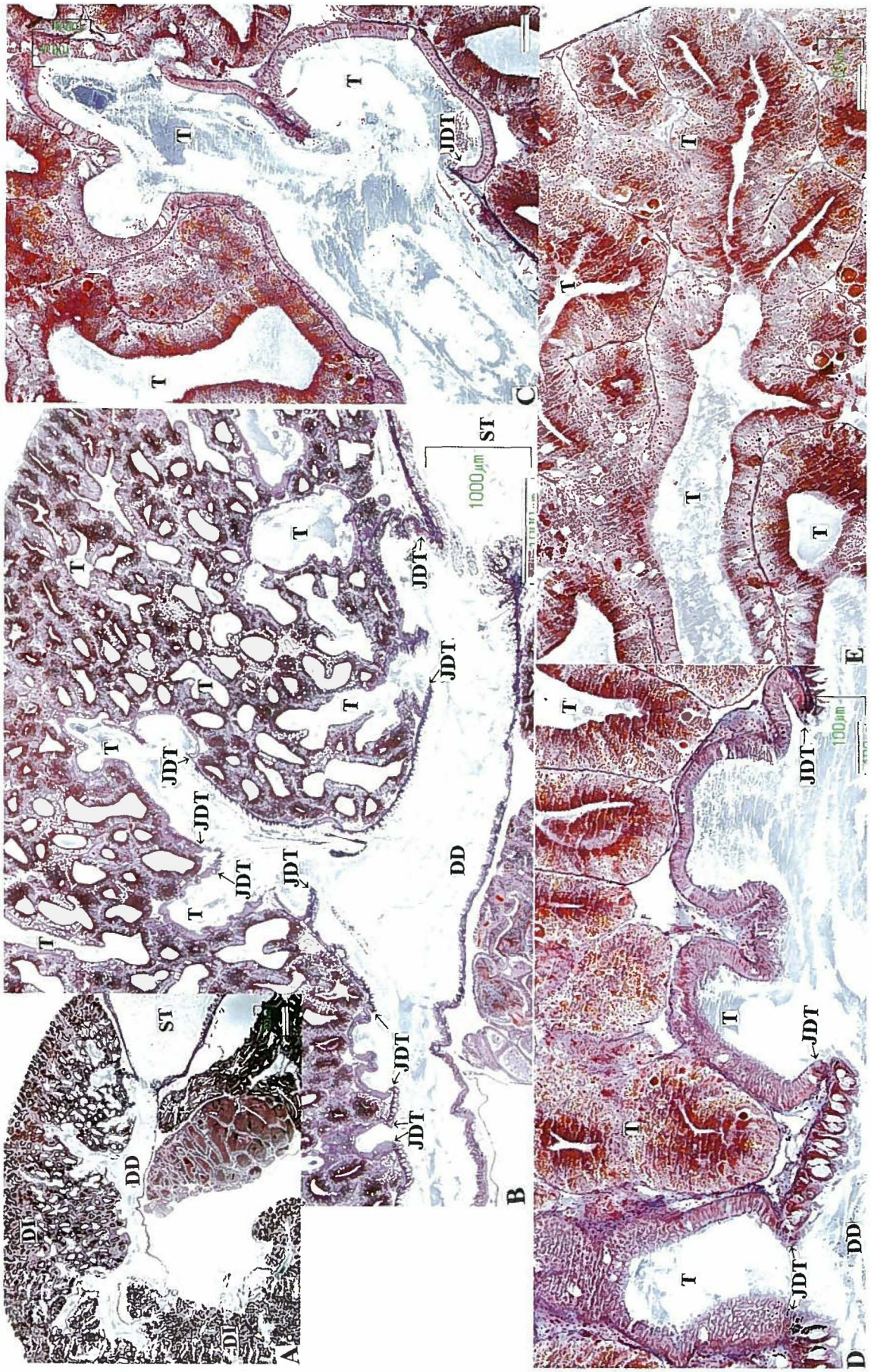

Fig. 16-3. Longitudinal sections of digestive diverticula of *Bufonaria rana*. DI, digestive diverticula; DD, duct; T, tubule; JDT, junction of the duct with a tubule. Azan stain. Bars in A and B = 1 mm, and bars in C-E = 100 μ m.