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3 **Palynological and paleobotanic characterization of upper Eocene-lower**
4 **Miocene deposits of the southeastern part of the onshore sedimentary basin**
5 **of Côte d'Ivoire**
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8
9 **ABSTRACT**
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11 Samples from two boreholes in Bingerville and Assinie were the subject of this study. The
12 main objective of this work is to make an inventory of the plant species that existed at the
13 time of the establishment of these formations on both sides of the lagoon fault. The samples
14 were processed according to the classical procedure of extraction and concentration of
15 palynomorphs.

16 The palynostratigraphic analyzes revealed a palynoflora characterizing the upper Eocene and
17 the lower Miocene. The lithology consists of sands and clays for the Bingerville well and
18 sands, green clays and limestones for the Assinie well.

19 These green clays contain glauconites and remains of marine organisms, evidence of a
20 transgressive sea at this time. Paleovegetation consists of freshwater species such as
21 *Verrucatosporites usmensis*, *Laevigatosporites ovatus*, *Polypodiaceiosporites regularis*, and
22 *Deltoidospora delicata*, which develop in a coastal wetland environment under a tropical
23 climate with alternating warm and humid periods.
24

25 *Keywords: palynomorphs; paleobotanic; Miocene; Eocene; Bingerville; Assinie.*
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29 **281. INTRODUCTION**

30 The basin of Côte d'Ivoire in which this study is located, is part of a large set of coastal basins
31 bordering the west Atlantic coast from southern Morocco to beyond Angola [1].

32 Palynological studies on the ivorian sedimentary basin began in 1960 with the work of [2],
33 devoted to Cretaceous deposits.

34 Also, other contributions from the palynological study to the knowledge of the stratigraphy of
35 the ivorian basin have been made, sometimes on Tertiary deposits [3, 4, 5, 6], sometimes
36 Cretaceous [7, 8].

37 Many unpublished dissertation studies (DEA) dissertations have also provided data on the
38 biostratigraphy of Tertiary age deposits [9, 10, 11] and upper Cretaceous age [12, 13, 14].

39 The present study was undertaken to date the formations of these two wells made in the
40 ivorian onshore basin on both sides of the Lagoons fault in order to contribute to the
41 paleobotanic reconstruction of the region which remains enigmatic.
42

43 **2. PRESENTATION OF THE STUDY AREA**

44 The study area (Fig. 1) is located south east of the ivorian sedimentary basin on both sides of
45 the lagoon fault. Two wells made at Bingerville (P1) and Assinie (P2), the geographical
46 coordinates and depths of which are given in Table 1 below are concerned to this study.

47 The geological history of the sedimentary basin of Côte d'Ivoire is linked to the opening of the
48 south Atlantic, the consequence of which is the dislocation of Gondwana, which intimately
49 united south America and Africa. This story recently recalled by [15] indicates that this basin
50 is characterized by two distinct domains.

51

52 a) a continental domain or onshore basin area affected by a major "lagoon fault" along the
53 coast from west to east. This accident has a vertical discharge of several thousand meters
54 (4000 - 5000 m).

55 (b) a marine domain or offshore basin known only through oil drilling. This offshore basin is
56 subdivided into two margins including the margin of Abidjan and that of San-pedro.

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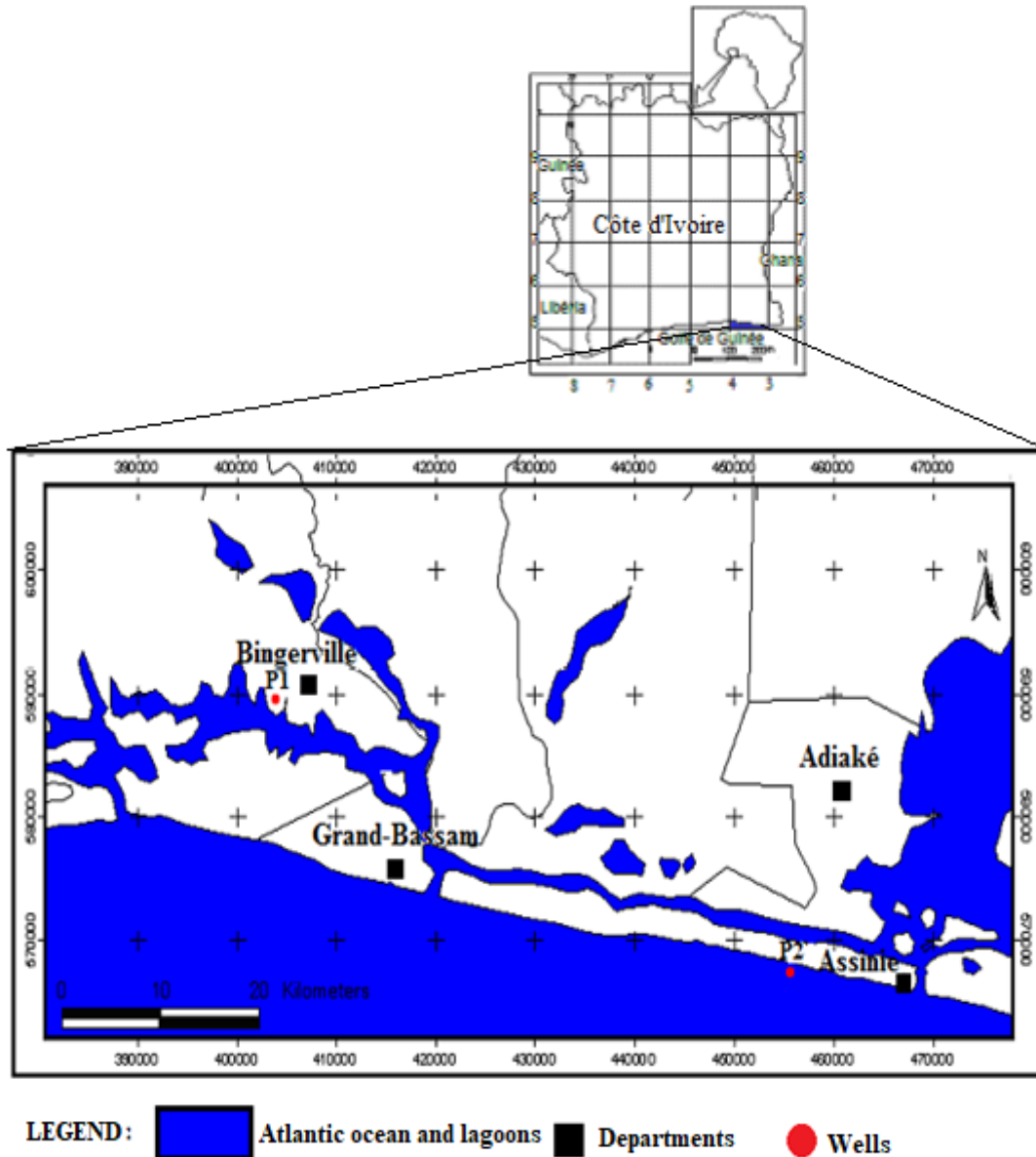
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59 **Table 1. Coordinates of the wells**

60

Site	Désignation	Longitude (w)	Latitude (N)	Depth in meter
Bingerville	P1	03° 52' 53,8"	05° 20' 06,8"	120
Assinie	P2	03° 24' 02,3"	05° 08' 54,8"	180

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62
63 **Fig. 1. Location of wells**

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65 **3. MATERIALS AND METHODS**

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67 The material used consisted of twenty-five (25) samples of cuttings from two water wells
68 located at Bingerville (10 samples) and Assinie (15 samples). Each cuttings sample was
69 palynologically prepared as practiced in paleobotany laboratories [3].

70 It consists of destroying all the mineral phases of the sediment with strong acids (30% HCl
71 and 70% HF) and preserving the organic phase generally consisting of sporopollenic
72 materials.

73 A final attack with nitric acid (HNO₃) 68% cold whose purpose is to clear the palynological
74 material and organic matter content. After this last attack, the residue is sieved on a 10 μm
75 single-use cloth and then the sporopollenic residue obtained is mounted between the blade and
76 the coverslip using a special resin.

77 Using a biological microscope, observations are made to identify the palynomorphs contained
78 in the slides. These palynomorphs made it possible to date the formations studied and to

79 characterize the paleoenvironment of the region. The resulting paleobotany analysis is based
 80 on the ecological importance and the different botanical affinities of sporomorphs.

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83 **4. RESULTS**

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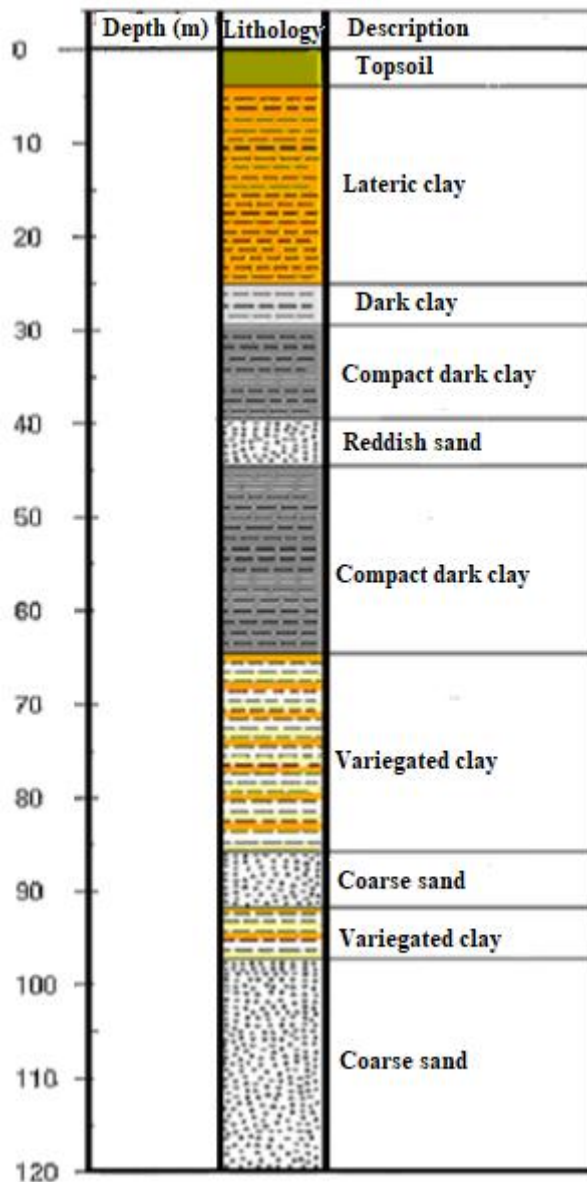
85 **4.1 Lithological analysis of the wells**

86 **4.1.1 Lithology of the Bingerville well**

87

88 The lithology of cuttings from the well (P1) located in Bingerville shows in the direction of
 89 sedimentation (Fig. 2): coarse white sand (120 - 97m); sandy variegated clays (97 - 92m);
 90 coarse sands (92 - 86 m); compact variegated clays and dark clays (86-44 m); reddish-brown
 91 sands (44 - 39 m) testifying to a strong presence of ferric oxide; very compacted dark clays
 92 (39 -25 m) and yellow-orange laterite clays (25-2 m).

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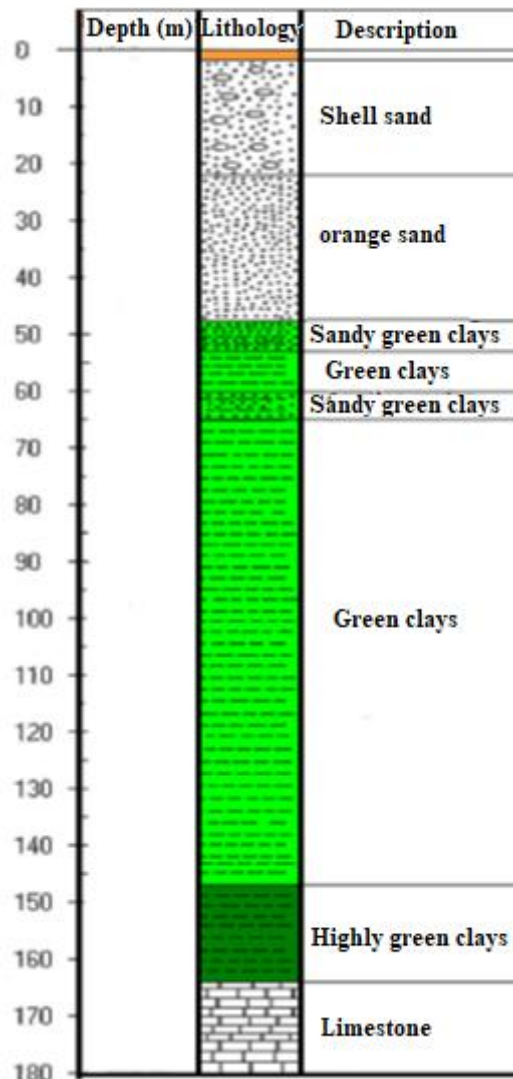
95 **Fig. 2. Lithological synthesis of the P1 well**

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4.1.2 Lithology of the Assinie well

100 The lithological analysis of the cuttings of the Assinie well (P2) shows in the direction of
101 sedimentation (Fig. 3): glauconious limestones of greenish gray color with shell debris (180-
102 164 m); very green clays, past calcareous plastics, rich in glauconites (164 - 65 m), sandy
103 clays (65-47m); coarse orange-yellow sands, with rare shelly debris (47 - 23 m); medium to
104 fine shellfish sands, of a light yellow color rich in shellfish debris of bivalves (23 - 2 m).
105
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107

108 **Fig. 3. Lithological synthesis of the P2 well**

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4.2 Quantitative analysis of P1 and P2 wells

110

111 The palynomorphs of the well P1 are composed mainly of spores and pollen grains (85%) and
112 scarce dinocysts (15%). The state of conservation of these palynomorphs is excellent.

113

114 The palynological material of the well P2 is composed of spores and pollen grains (73%) as
115 well as dinocysts (27%). This quantitative study has made it possible to observe many fossil
116 palynomorphs, some of which are of stratigraphic interest.

117 Table 2. Palynomorph Count Sheet in well P1

STAGE	DEPTH IN METER	TOTAL DINOCSYSTS	DINOCSYSTS				SPORE AND POLLEN GRAIN														
			<i>Batiacospharea</i> sp.	<i>Lingulodinium machaerophorum</i>	<i>Selenophex quanta</i>	<i>Operculodinium centrocarpum</i>	<i>Cupressacites hiatipites</i>	<i>Verrucosporites usmensis</i>	<i>Retitricolporites irregularis</i>	<i>Polyadipollenites microreticulatus</i>	<i>Striatopollis catantubus</i>	<i>Retitricolporites sp.</i>	<i>Psilatricolporites crassus</i>	<i>Verrucosporites complanatus</i>	<i>Psilatricolporites laevigatus</i>	<i>Monocolpopollenites sp.</i>	<i>Inaperturopollenites sp.</i>	<i>Magnaperiporites spinosus</i>	<i>Monosulcites sp.</i>	<i>Retimonocolpites irregularis</i>	<i>Laevigatosporites ovatus</i>
Lower Miocene	30	15					2	6	1	1		1			2	1					1
	34	12					1	3	2	2		1			1	1					1
	42	23						13	1	2	1	2			1	1					2
	47	17			1		5	1	1	3	3			1	2						1
Upper Eocene	53	20			2		6	2			2	2	1	3	2	1					1
	59	16			1		3	2			1	1	2	1	2	1					3
	64	16	2		2		4	3			1	1	1	1	1	1	1				2
	70	20	5		1		2	3			3	2	1	1	2	2	2				2
	75	18	3	1	3		3	1			1	2	1	2	1	2	1	1	1	1	2
	94	23	6	1	2	2	4	1			4	1	3	2	1	1	2	1	1	1	2
TOTALS			16	2	12	2	3	49	17	6	4	19	9	9	15	14	8	6	2	2	17

118

119

120 Table 3. Palynomorph Count Sheet in well P2

STAGE	DEPTH IN METER	TOTAL DINOCSYSTS	DINOCSYSTS							SPORE AND POLLEN GRAIN																
			<i>Batiacospharea</i> sp.	<i>Spiniferites ramosus</i>	<i>Cordosphaeridium inodes</i>	<i>Cometodinium obscurum</i>	<i>Operculodinium centrocarpum</i>	<i>Isbelidium sp.</i>	<i>Lingulodinium machaerophorum</i>	<i>Brevicolporites molinae</i>	<i>Laevigatosporites ovatus</i>	<i>Margotricolporites rauwolfii</i>	<i>Deltoidospora delicata</i>	<i>Cingulatisporites sp.</i>	<i>Tricolpites sp.</i>	<i>Leiotrites adriennis</i>	<i>Baculatisporites sp.</i>	<i>Retitricolporites sp.</i>	<i>Verrucosporites usmensis</i>	<i>Pachydermites diderixii</i>	<i>Retitricolporites irregularis</i>	<i>Spinizonocolpites echinatus</i>	<i>Cicatricosporites dorogensis</i>	<i>Polyodiaceisporites regularis</i>	<i>Momipites sp.</i>	<i>Retitricolporites sp.</i>
Lower Miocene	52	13								1				1	1	1	5							1		
	60	12								1				1	1	2	1							3		
	64	20								2	2	3	1	2	3	2	4							1		
	71	22	2							2	3	2	1	1	3	1	8							1		
	76	14	1							1	1	1	1	1	2	3	3							1		
	82	13	1							1	2	1		1	2	1	2								2	
Upper Eocene	94	12	1	1	2	1	1	1	1				1		2		1	2	1	1	1	1	1	1		
	103	17	2	1	1	1	2	1	1				1		1		4	1	2	2	1	2				
	112	17	1	2	1	1	1	1	1				1		1		2	1	1	1	2	2				
	121	20	1	1	2	2	1	2	1			3		1		3	1	2	2	1	1	1	1		1	
	130	25	2	3	1	2	2	1	1			1		1		11	1	1	2	1	1	1	1	1	1	
	139	18	1	1	1	3	3	1	1			1		1		5	1	1			1	2	1	1	1	
	144	16	1	1	1	2	2	2	2			2		1		1	1	1			1	1	1	1	1	
	152	17	2	3	2	2	1	1	1			1		2		2	2	1	1		1	2		3		
	165	15		2	1	1	1	1	1			4	1	2		1		2	1	2		1			1	
	TOTALS			15	15	12	15	14	11	10	8	19	26	9	7	13	10	24	10	54	10	12	8	10	21	3

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123 **4.3 Palynostratigraphy**

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125 ➤ **Well P1**

126 Palynological analysis of the Bingerville well (P1) revealed two stages (Fig. 4), defined by
127 associations composed mainly of spores and pollen grains and rare dinocysts.

128

129 - **The lower Miocene** ranges from 25 m to 51 m and is characterized by the following
130 spores and pollen grains: *Hiatipites Cupressacites*, *Laevigatosporites ovatus*,
131 *Polyadopollenites microreticulatus*, *Psilatricolporites laevigatus*, *Striatopollis*
132 *catatumbus*, *Retitricolporites irregularis*, *Verrucatosporites usmensis*, *Retitriporites sp.*
133 and *Monocolpopollenites sp.*

134

135 - **The upper Eocene** ranges from 51 m to 120 m is marked by species of spores and pollen
136 grains such as: *Psilatricolporites crassus*, *Verrustephanocolporites complanatus*,
137 *Retitricolporites irregularis*, *Verrucatosporites usmensis*, *Retimonocolpites irregularis*.
138 These spores and pollen grains are associated with the following dinocysts:
139 *Selenopemphix quanta*, *Batiacasphaera sp.*, *Spiniferites ramosus* and *Cleistosphaeridium*
140 *flexuosum*.

141

142 ➤ **Well P2**

143 Palynological analysis of the P2 well also highlighted two stages as well (Fig. 5).

144

145 - **The lower Miocene** range from 47 to 85 m is revealed by the palynological association
146 composed of spores and pollen grains such as *Laevigatosporites ovatus*, *Leiotriletes*
147 *adriennis*, *Polypodiaceosporites regularis*, *Polypodiisporites speciosus*, *Cingulatisporites*
148 *sp.*

149 - **The upper Eocene** extends from 85 to 180 m and is marked by spores and pollen grains
150 characteristic of the upper Eocene such as *Pachydermites diederixii*, *Retitricolporites*
151 *irregularis*, *Spinizonocolpites echinatus*, *Cicatricosporites dorogensis*, *Margotricolporites*
152 *rauvolfii*, *Verrucatosporites usmensis*. To these spores and grains of pollen are associated
153 dinocysts such as *Cometodinium obscurum*, *Spiniferites ramosus*, *Operculodilium*
154 *centrocarpum*, *Batiacasphaera sp.*, *Cordosphaeridium inodes*, *Isabelidium sp.* and
155 *Lingulodinium machaerophorum*.

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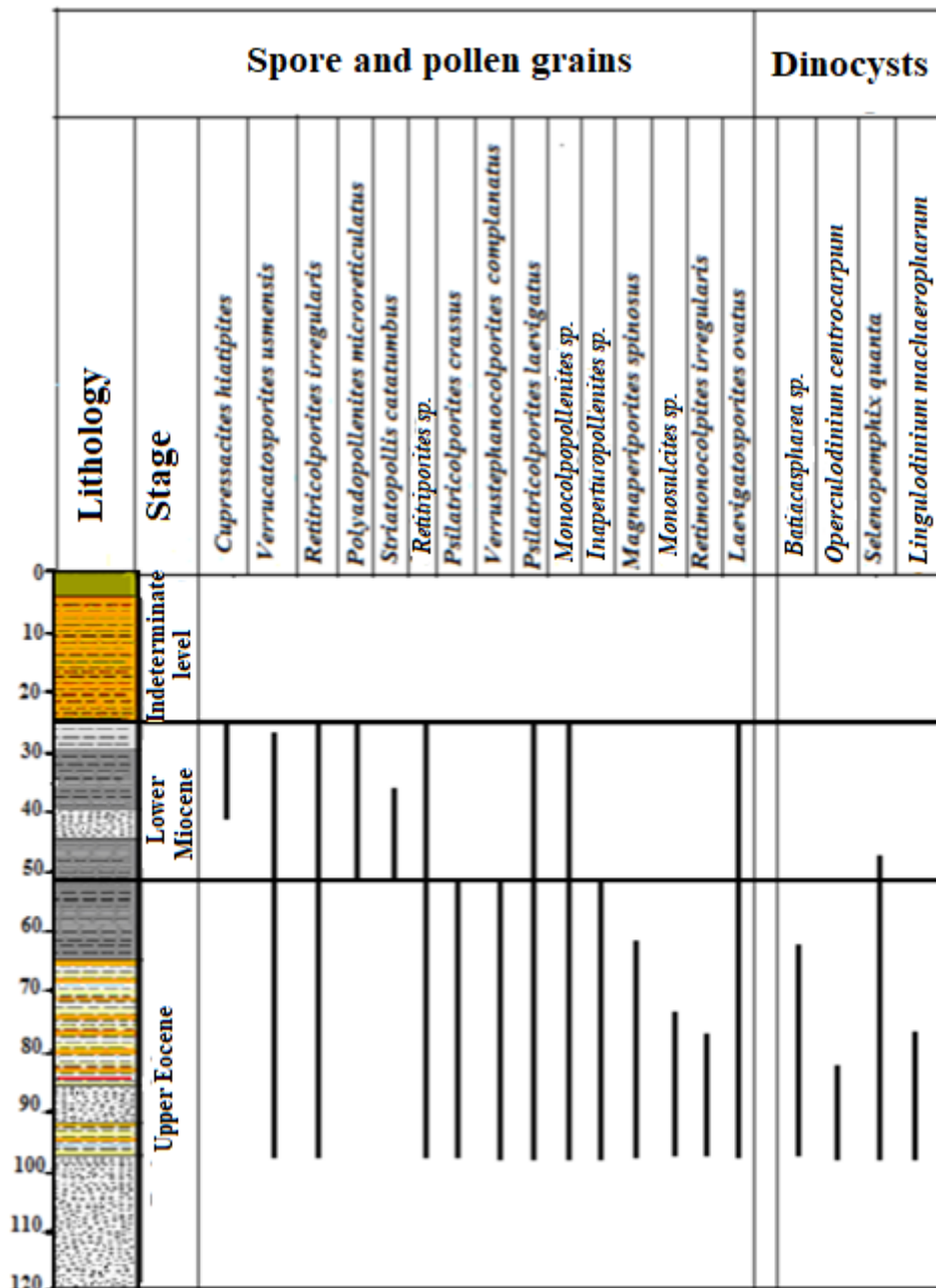
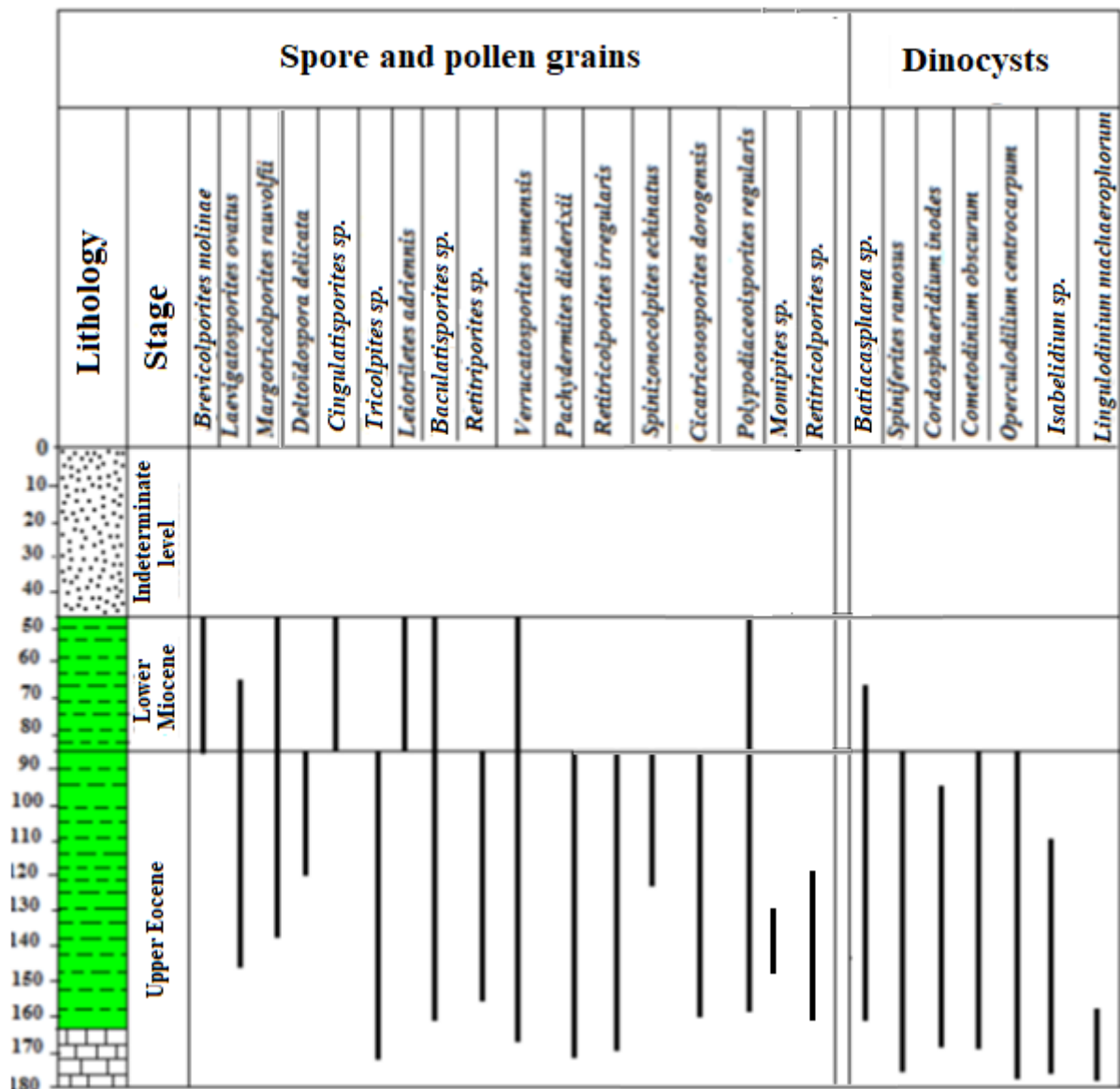


Fig. 4. Vertical distribution of the main Bingerville palynomorphs (P1)

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164 Fig. 5. Vertical distribution of the main Assinie palynomorphs (P2)

165 **4.4 Paleobotanical characterization**

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167 The paleobotanical study of these 2 wells shows the presence of pollen grains from the
 168 Arecaceae (*Retitricolporites Irregularis*, *Monocolpopollenites* sp.), Fabaceae (*Striatopollis*
 169 *catatumbus*), Schizeaceae (*Inaperturopollenites* sp.), Pelliceria (*Psilatricolporites crassus*),
 170 *Nypa* (*Spinizonocolpites echinatus*, *retimonocolpites irregularis*), Apocynaceae
 171 (*Margotricolporites rauwolfii*, *Brevitricolporites molinae*). These pollen grains are associated
 172 with spores of Polypodiaceae (*Laevigatosporites ovatus*, *Verrucatosporites usmensis*,
 173 *Polypodiaceosporites regularis*), Schizeaceae (*Cicatricosporites dorogensis*, *Leiotriletes*
 174 *adriennis*), to Cyatheaceae (*Deltoidospora delicata*) and to Lygodium (*Crassoretitriletes*
 175 *vanraadshooveni*).

176 Palynoflora consists of angiosperm pollen grains from tropical rainforests and coastal swamps
 177 (*Pachidermites diderixii*, *Retitricolporites irregularis* and *Striatopollis catatumbus*), ancestors
 178 of the present-day palm trees of the genus *Nypa* (*Spinizonocolpites echinatus*,
 179 *retimonocolpites irregularis*), fern spores basically hygrophilous freshwaters that develop in
 180 moist, swampy areas (*Laevigatosporites ovatus*, *Verrucatosporites usmensis*,
 181 *Polypodiaceosporites regularis*).

182 This palynoflora indicates a tropical paleoclimate with alternating warm and humid periods.
183 The association of coastal marine ecosystems (*Cordosphaeridium inodes*, *Spiniferites*
184 *ramosus*) with this paleovegetation indicates a coastal marine ecosystem in this area.
185

186

187 5. DISCUSSION

188

189 Palynostratigraphically

190

191 Palynological analysis revealed lower Miocene and upper Eocene. Lower Miocene has been
192 identified through associations of *Cupressacites hiatipites*, *Laevigatosporites ovatus*,
193 *Polyadopollenites microreticulatus*, *Psilatricolporites laevigatus*, *Striatopollis catatumbus*,
194 *Retitricolporites irregularis*, *Verrucatosporites usmensis*, *Leiotriletes adriennis*,
195 *Polypodiaceoisporites regularis*, *Retitriporites sp.*

196 Our results are consistent with those of [16, 17, 18], who used some of these sporomorphs
197 respectively in Soudan and Côte d'Ivoire to characterize the lower Miocene.

198 The species *Crassoretitriletes vanraadshooveni* extends from Miocene to Pliocene in Nigeria
199 [19] and middle Miocene to Pleistocene in Venezuela [20]. As for *Verrucatosporites*
200 *usmensis*, it characterizes the Eocene-Pleistocene interval in Nigeria and Borneo [19, 21].

201 *Laevigatosporites ovatus* is known in the Neogene in Burundi [22] and Paleogene in Nigeria
202 [23].

203 *Striatopollis catatumbus* characterizes the Paleocene-Pleistocene interval in Nigeria [19] and
204 the Pleistocene Eocene in Venezuela [20].

205 *Brevicolporites molinae* marks Oligocene and lower Miocene in Cameroon [21] and Miocene
206 in Soudan [16].

207 The species *Retitriporites sp.* is a good marker of upper Oligocene and lower Miocene in
208 Soudan [16]. However, the absence of *Lejeunecysta* (good marker of the Oligocene in Côte
209 d'Ivoire) [7] in this interval restricts this age to the lower Miocene.

210 The Upper Eocene was highlighted thanks to the associations of *Psilatricolporites crassus*,
211 *Verrustephanocolporites complanatus*, *Retitricolporites irregularis*, *Verrucatosporites*
212 *usmensis*, *Retimonocolpites irregularis*, *Pachydermites diderixii*, *Spinizonocolpites*
213 *echinatus*, *Cicatricosporites dorengensis*, *Margotricolporites rauwolfii*.

214 Indeed [24, 25, 26, 27] with its same palynomorphs has evidenced the upper Eocene in the
215 Cameroun Basin. To these spores and grains of pollen are associated dinocysts such as
216 *Cometodinium obscurum*, *Spiniferites ramosus*, *Operculodilium centrocarpum*,
217 *Batiacasphaera sp.*, *Cordosphaeridium inodes*. [28], considers the species *Cordosphaeridium*
218 *inodes* as an indicator of the Eocene in Germany, while [29] attributes it to the middle
219 Oligocene in Australia.

220 The species *Spinizonocolpites echinatus* makes its last appearance in the upper Eocene in
221 many works [19, 26, 30, 31, 32] in Nigeria, Cameroun, Soudan and Ghana.

222 *Psilatricolporites crassus* characterizes the upper Paleocene and lower Eocene. In Cameroun,
223 [26] identified it in the lower Eocene and middle Eocene. In Nigeria this species has been
224 used by [19] to characterize the late Pleocene-Pleistocene interval. In South America, this
225 species characterizes the lower Eocene-Middle Eocene [30, 33].

226 The species *Pachydermites diderixii* present in this stage characterizes the Eocene and
227 Miocene in Cameroon [26], Oligocene and Miocene in Soudan [16].

228 However, the presence in this stage of *Lingulodinium machaerophorum*, an Eocene marker in
229 Egypt [34] and *Cordosphaeridium inodes* known from Maastrichtian to upper Eocene [7, 23,
230 31, 35, 36] restricts this age to the upper Eocene.

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232

233 **Paleobotanically**

234 Paleobotanically, our work in agreement with those [18] showed that the assemblage
235 composed of *Verrucatosporites usmensis*, *Retitricolporites irregularis*, *Laevigatosporites*
236 *ovatus*, *Leiotriletes adriennis*, *Pachydermites diderixii*, *Polypodiaceosporites regularis* is
237 characteristic of tropical climates hot and humid.

238 The presence of the pollen grain *Brevitricolporites molinae* (Apocynaceae) typical of tropical
239 forests [21] is confirmed in our work.

240 In addition, the results of [37] in conformity with ours reveal that fern spores such as
241 *Laevigatosporites ovatus*, *Leiotriletes adriennis*, and *Verrucatosporites usmensis* indicate a
242 humid tropical climate. This author also states that the species *Psilatricolporites crassus* is a
243 pollen grain from mangrove vegetation which has been verified by our work.

244 The results of [38] reported by [39] indicate, as in our work, that Polypodiaceae
245 (*Polypodiaceosporites regularis*) are derived from tree ferns that indicate a thick and closed
246 tropical forest.

247 For [39, 40], the genus *Striatopollis catatumbus* encountered in our formations is a species of
248 freshwater and coastal swamps. These results are verified by our work. These authors also
249 claim that they can be found in the coastal plains and also in tree savannas.

250 Similarly, our work is verified by those of [41]. They claim that dinocysts such as
251 *Operculodinium centrocarpum*, *Spiniferites ramosus*, *Cordosphaeridium inodes* and
252 *Batiacasphaera sp.* indicate a marine deposit environment near the coast.

253

254 **6. CONCLUSION**

255 The palynostratigraphic and paleobotanical study of the sedimentary deposits of the 2 wells of
256 Bingerville and Assinie revealed some characteristics

257 The lithology indicates the presence of dark, variegated sand and clays in the Bingerville well

258 The presence of shell sands, glauconious green clays and limestone in the Assinie well

259 These green clays contain remains of marine organisms, evidence of a transgressive sea at this
260 time. The palynostratigraphic analyzes revealed a palynoflora characterizing the upper Eocene
261 and the lower Miocene. Paleovegetation reveals the presence of species that develop in a
262 mangrove environment with moist, lowland, partly marshy forest in a tidal estuarine coastal
263 environment.

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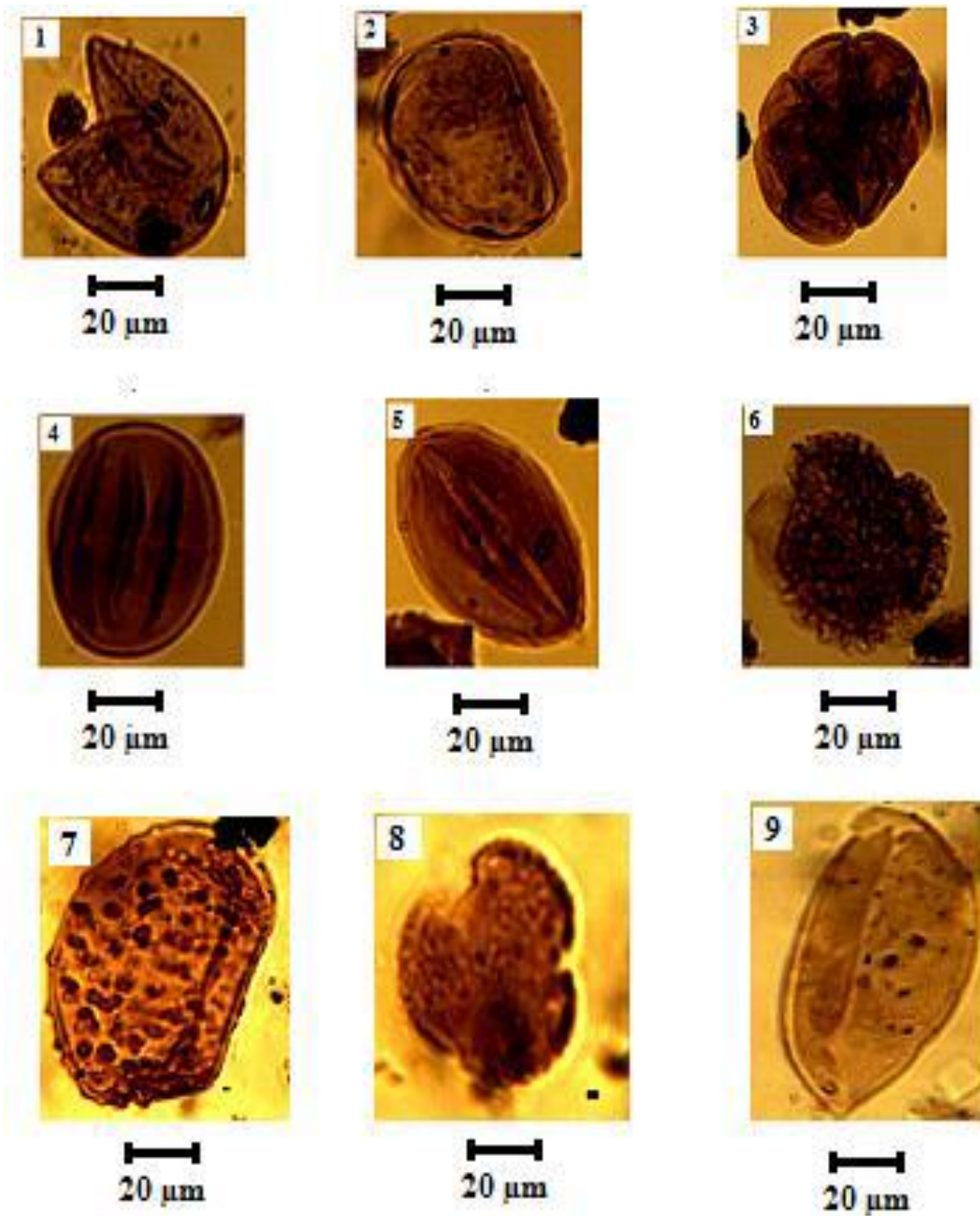
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277 *1.Cupressacites hiatipites*; *2.Laevigatosporites ovatus* ;*3.Polyadopollenites microreticulatus* ; *4.*
 278 *Psilatricolporites laevigatus* ;*5. Striatopollis catatumbus* ;*6. Retitricolporites irregularis*; *7. Verrucatosporites*
 279 *usmensis* ;*8. Retitriporites sp.* ; *9. Monocolpolleniites sp.*

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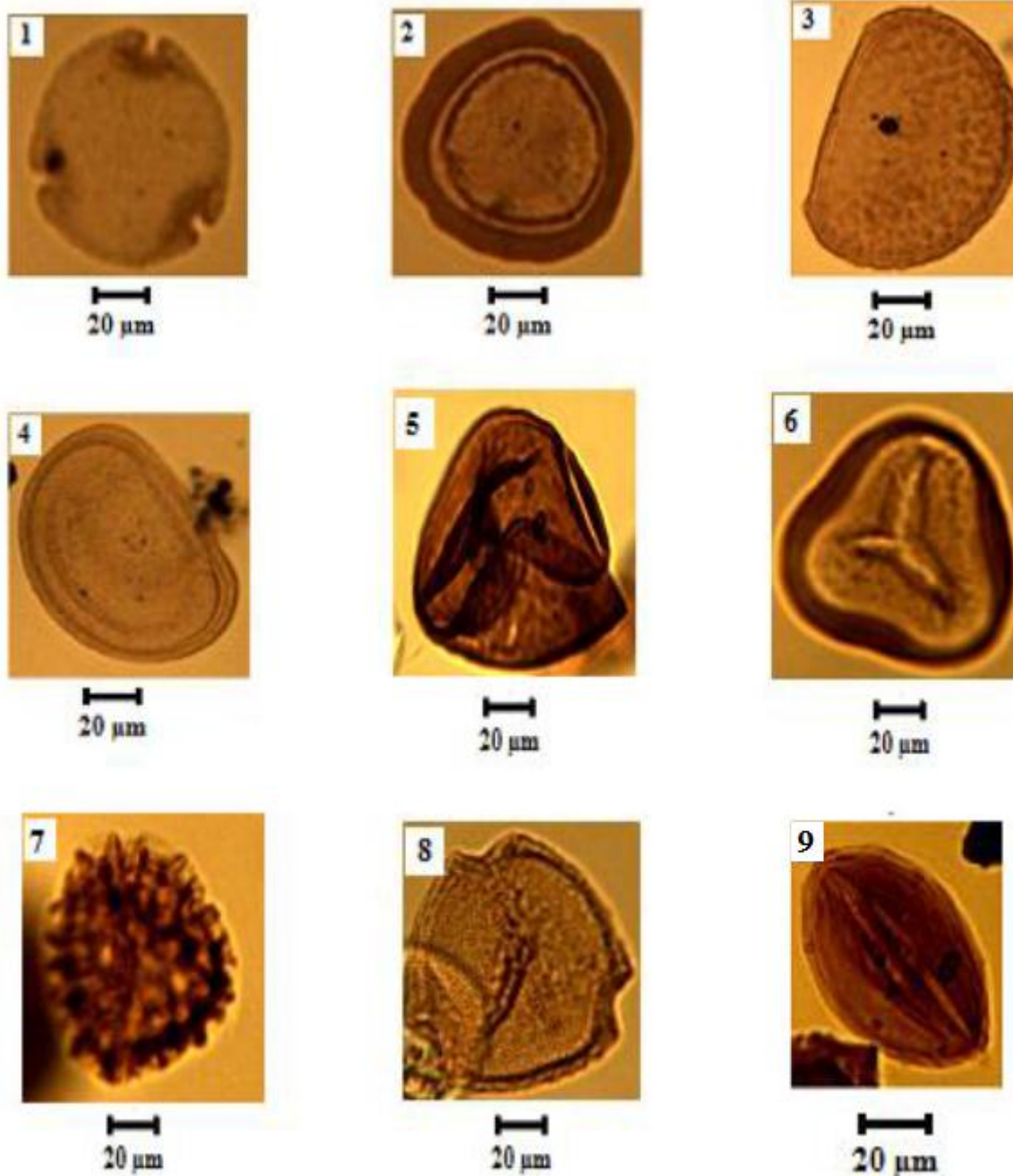
281 **Fig. 6. Spores and pollen grains from the lower Miocene of Bingerville**

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 287 1. *Brevicolporites molinae* ; 2. *Cingulatisporites sp.* ; 3. *Verrucatosporites usmensis* ; 4. *Laevigatosporites*
 288 *ovatus* ; 5. *Leiotriletes adriennis* ; 6. *Polypodiaceoisporites regularis* ; 7. *Baculatisporites sp.*; 8.
 289 *Margotricolporites rauvolffii* ; 9. *Striatopollis catatumbus*
 290

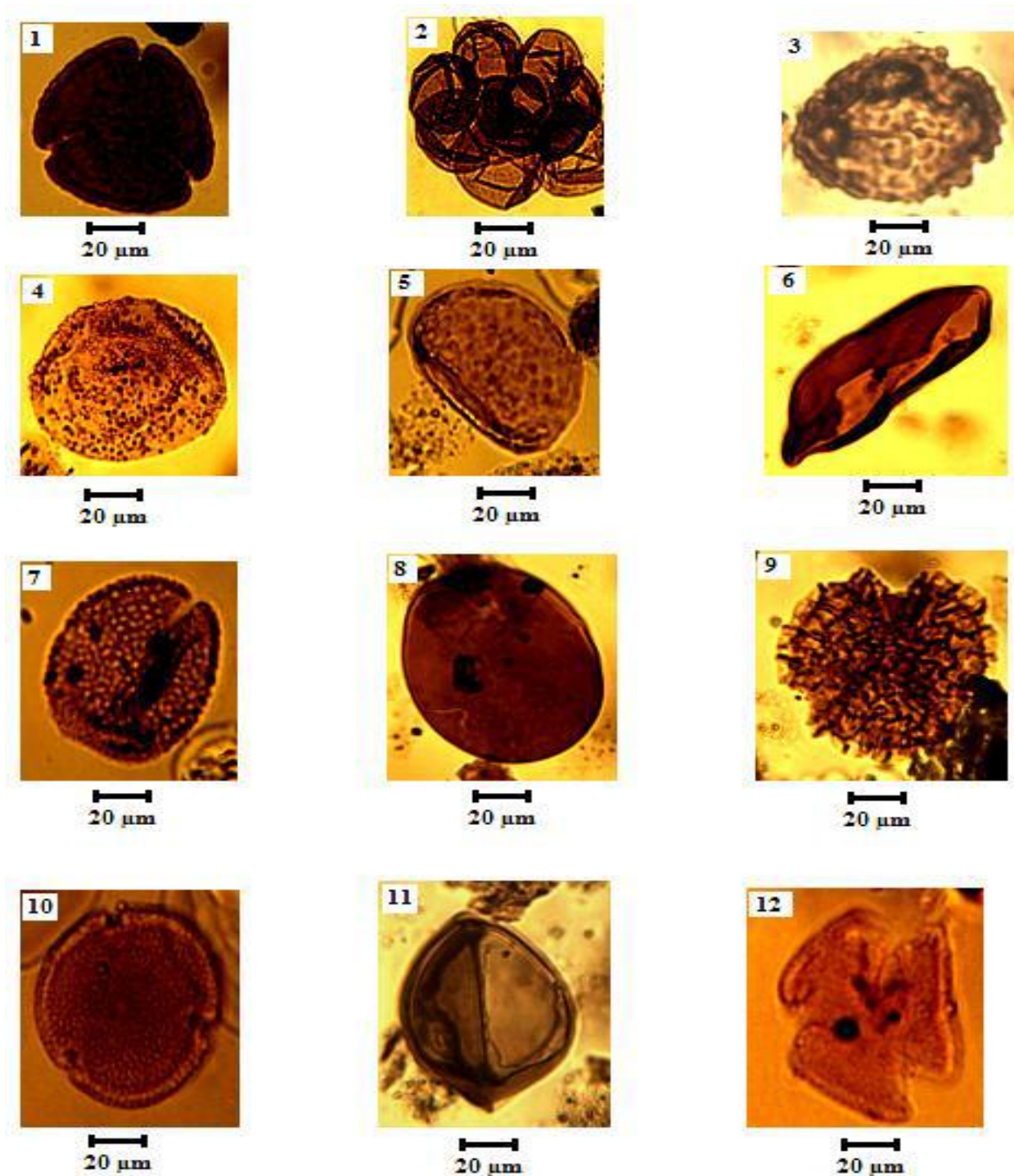
291 **Fig. 7. Spores and pollen grains from the lower Miocene of Assinie**

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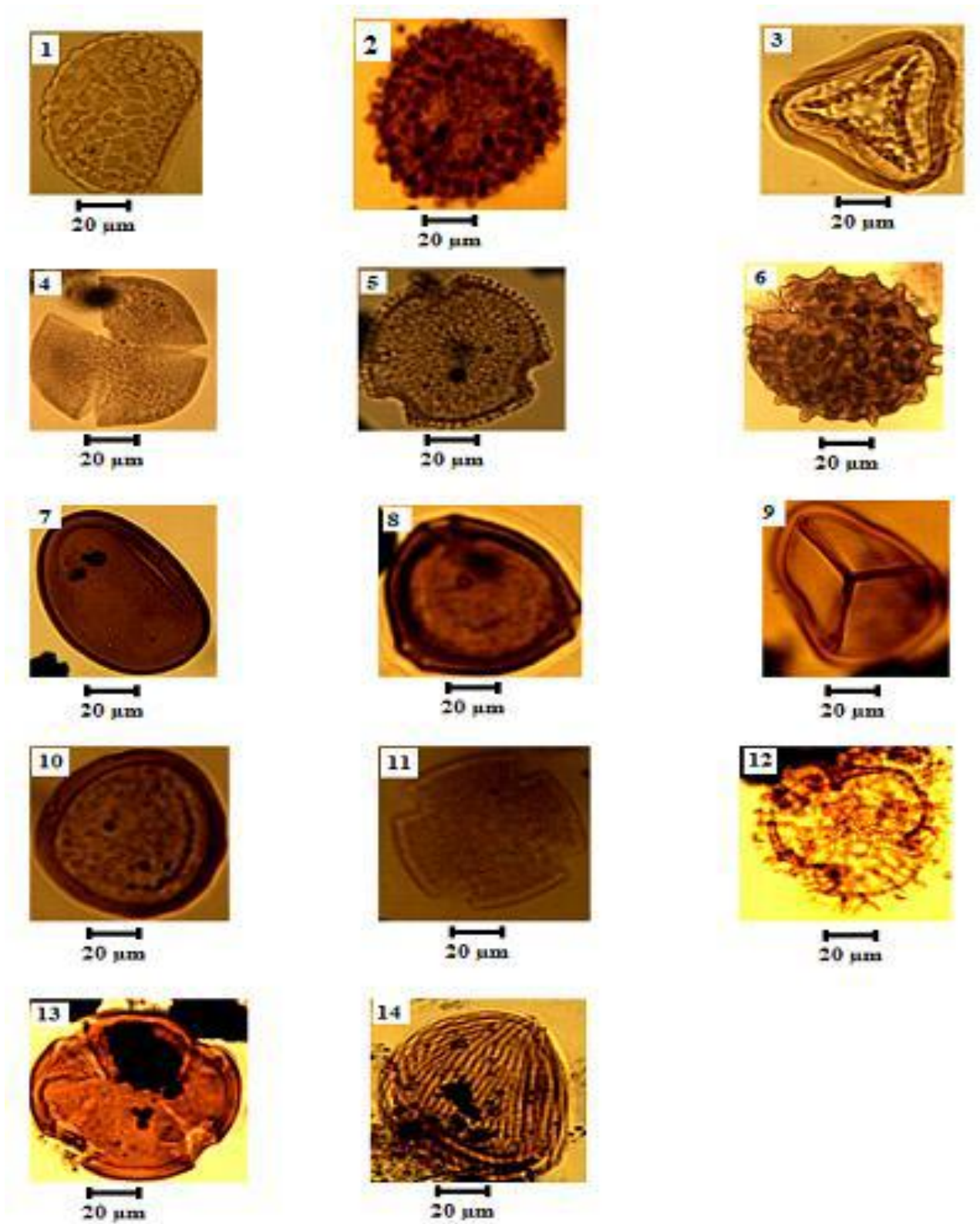
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297 1. *Psilatricolporites crassus*; 2. *Inaperturopollenites sp.*; 3. *Verrustephanocolporites complanatus*; 4.
 298 *Magnaperiporites spinosus*; 5. *Verrucatosporites usmensis*; 6. *Monosulcites*; 7. *Retimonocolpites irregularis*;
 299 *Laevigatosporites ovatus*; 9. *Retitricolporites irregularis*; 10. *Retitriporites sp.*; 11. *Monocolpopollenites*;
 300 *Retitricolpites sp.*

301 **Fig. 8. Spores and pollen grains from the upper Eocene of Bingerville**

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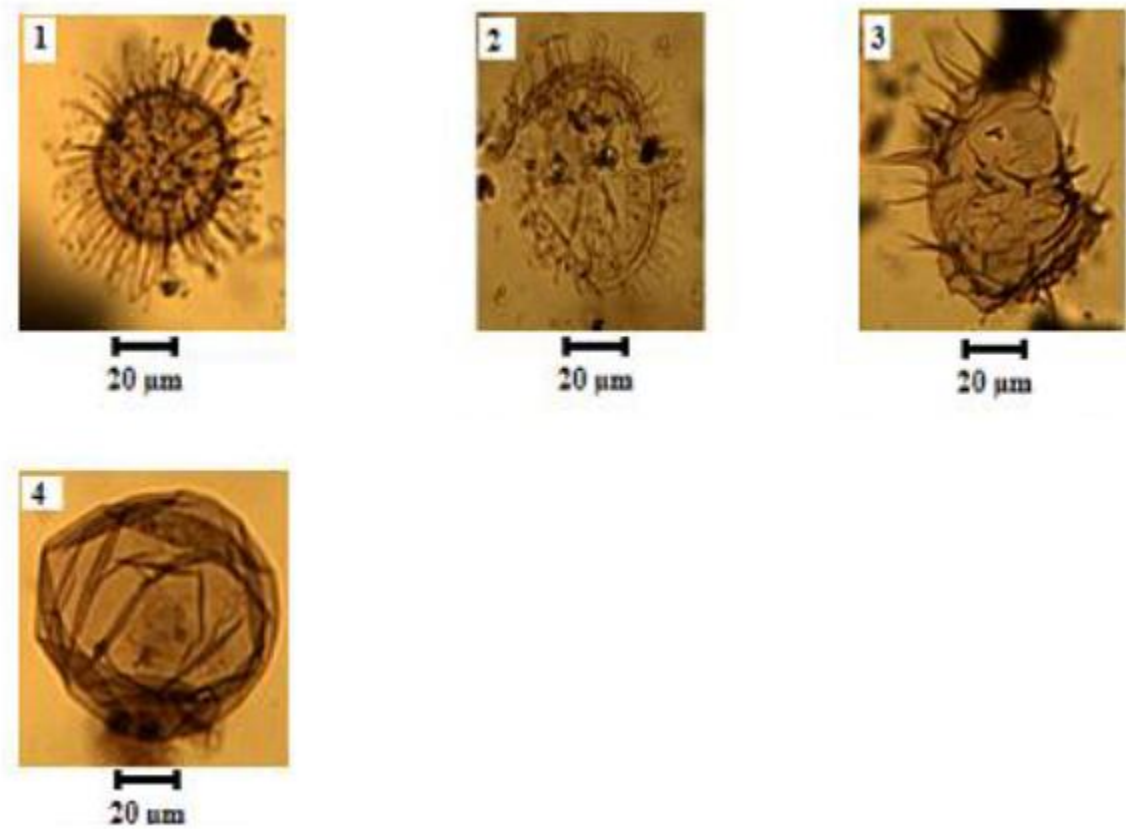
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305 1. *Verrucatosporites usmensis* ; 2. *Baculatisporites* ; 3. *Polypodiaceoisporites regularis* ;4. *Tricolpites* ;
 306 5. *Retitriporite* sp. ; 6. *Spinizonocolpites echitanus* ; 7. *Laevigatosporites ovatus* ; 8. *Momipites* sp. ; 9.
 307 *Deltoidospora delicata* ; 10. *Cingulatisporites* ; 11-13. *Pachydermites diderixii* ; 12. *Retitricolporites*
 308 *irregularis* ; 14. *Cicatricosporites dorengensis*.

309 **Fig. 9. Spores and pollen grains of the upper Eocene of Assinie**

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314 1. *Lingulodinium machaerophorum* ; 2. *Operculodinium centrocarpum* ;3. *Selenopemphix quanta* ; 4

315 *Batiacasphaera* sp.;

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317 **Fig. 10. Dinocysts of the upper Eocene of Bingerville**

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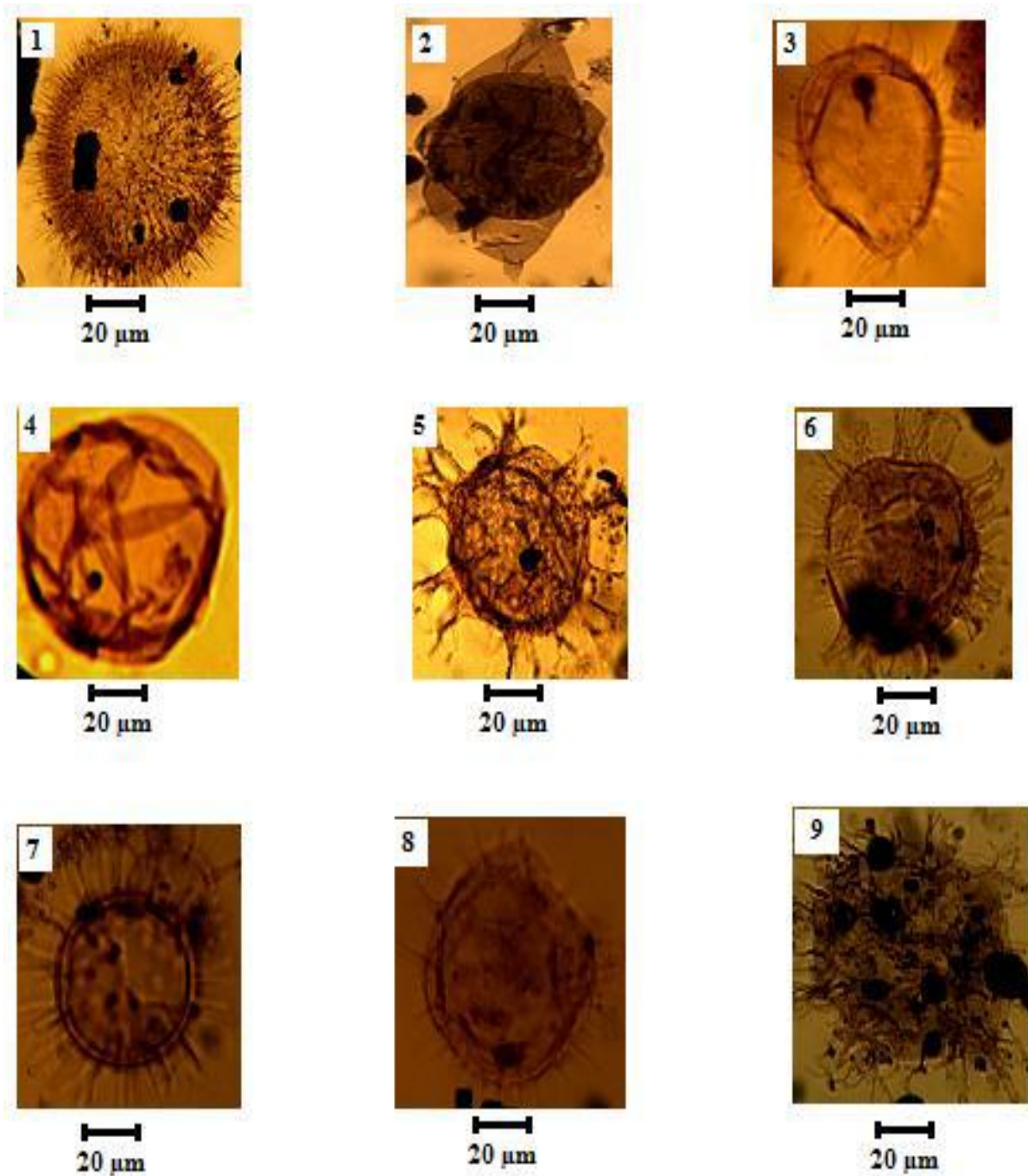
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 329 1. *Comotodinium obscurum*; 2. *Isabelidinium* sp.; 3-8. *Operculodinium centrocarpum*; 4. *Batiacasphaera* sp.; 5-
 330 9. *Spiniferites ramosus*; 6. *Cordosphaeridium inodes*; 7. *Lingulodinium machaerophorum*
 331

332 **Fig. 11. Dinocysts of the upper Eocene of Assinie**

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337 **APPENDIX**

338

339 **Spore and pollen grains**

- 340 *Baculatisporites* sp. (Jaramillo & Dilcher, 2001)
341 *Brevicolporites molinae* (Schuler & Doubinger 1970) Salard-Cheboldaeff 1978
342 *Cicatricosisporites dorogensis* (Potonié&Gelletich, 1933)
343 *Cingulatisporites* sp.
344 *Cupressacites hiatipites* (Wodehouse,1933) Krutzsch, 1971
345 *Deltoidospora delicata* (Sah, 1967)
346 *Inaperturopollenites* sp.
347 *Laevigatosporites ovatus* (Wilson & Webster, 1947)
348 *Leiotriletes adriennis* (Krutzsch, 1959)
349 *Magnaperiporites spinosus* (Gonzalez, 1967)
350 *Margotricolporites rauwolfii* (Salard-Cheboldaeff, 1978)
351 *Monocolpollenites* sp.
352 *Monosulcites* sp.
353 *Pachydermites diderixii* (Germeraad, & Muller, 1968)
354 *Polyadopollenites microreticulatus* (Salard, 1974)
355 *Polypodiaceoisporites regularis* (Zhang, 1981)
356 *Psilatriporites* sp.
357 *Psilatricolporites crassus* (Van der Hammen & Wijmstra 1964)
358 *Psilatricolporites laevigatus* (Van der Hammen and Wijmstra, 1964)
359 *Retimonocolpites irregularis* (Van der hammen & Wijmstra 1964)
360 *Retitricolpites* sp.
361 *Retitricolporites irregularis* (Van de Hammen & Wijmstra, 1964)
362 *Retitriporites* sp.
363 *Spinizonocolpites echinatus* (Muller, 1968)
364 *Striatopollis catatumbus* (González Guzmán, 1967) Ward, 1986
365 *Tricolpites* sp.
366 *Verrucatosporites usmensis* (Van der Hammen, 1956) Germeraad et al., 1968
367 *Verrustephanocolporites complanatus* (Salard-Cheboldaeff, 1978)

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372 **Dinocyst**

- 373 *Batiacasphaera* sp. (Jaramillo & Dilcher, 2001)
374 *Cometodinium obscurum* (Deflandre & Courteville, 1959) Monteil, 1991
375 *Cordosphaeridium inodes* (Klumpp, 1953) Eisenack, 1963
376 *Isabelidinium* sp.
377 *Lingulodinium machaeropharum* (Deflandre and Cookson, 1955) Wall, 1967
378 *Operculodinium centrocarpum* (Deflandre & Cookson, 1955) Wall, 1967
379 *Selenopemphix quanta* (Bradford, 1975) Harland, 1981
380 *Spiniferites ramosus* (Ehrenberg, 1838) Mantell, 1854

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