Appendix 1. – Listing of characters and character states coded for analyses.

CROWN (CR)

CR1 Symmetry
0: pentameral/subpentameral about the oral-aboral axis
1: poor bilateral symmetry
2: perfect bilateral symmetry
3: irregular
4: three-fold symmetry
5: tetragonal/triagonal

CR2 Crown attitude on column
0: erect
1: pendent
2: recumbent

CALYX (CA)

CA1 Calyx/aboral cup height (height/width)
0: very high: > 2.0
1: high: 2.0 to >1.25
2: medium: <1.25 to >0.75
3: low: <0.75 to >0.50
4: flat: < 0.50- >0.25
5: very flat: <0.25

CA2 Calyx/aboral cup profile
0: straight sides
1: convex sides -- widest at top of calyx/aboral cup
2: convex sides -- widest below top of calyx/aboral cup
3: concave sides
4: laterally compressed (Calceocrinidae)
5: adanally-abanally compressed (Calceocrinidae)
6: bilateral and subcylindrical (Calceocrinidae)
7: bilateral and vase shaped (Calceocrinidae)

CA3 Basic calyx plating
0: basically arranged in alternating circlets
1: basal circlet and radial circlet articulated on a fulcral ridge (Calceocrinidae)
2: irregular plating (as in protocrinoids)

CA4 Calyx plate suturing (degree to which calyx plates are attached to one another)
0: poor (easily crushed during compaction)
1: good (not easily crushed during compaction, but not ankylosed)
2: cemented (ankylosed)

CA5 Calyx plate thickness measured on radial plate
0: thin (<25% height or width)
1: thick (>25% height or width)

CA6 Calyx plate cross-sectional shape
0: flat
1: convex
2: nodose
3: spinose
4: concave

CA7 Sutures commonly distinct (visibility) on calyx and tegmen
0: absent
1: present

CA8 Calyx plate sculpturing (see Bohaty and Ausich)
0: smooth
1: finely nodose
2: coarsely nodose
3: finely granulose
4: coarsely granulose
5: coarse irregular nodes and pitting
6: finely pitted
7: coarsely pitted
8: with ridges
9: with stellate ridges
10: spine
11: movable, articulated spines
12: concave

CA9 Sculpturing at base of calyx
0: ridge absent
1: nodose
2: broken ridge/coalesced nodes
3: continuous ridge
4: variable in a species

CA10 Shape of circlet(s) at base of calyx
0: upright (visible in lateral view)
1: flat
2: concave

CA11 Calyx lobation at the position along which arms become free
0: absent
1: present

CA12 Short ray lobes built with fixed brachials
0: absent
1: present

CA13 Ligament pit on articulation between radial and basal circlets (for calceocrinids)
0: divided
1: undivided

CA14 Calyx plate addition
0: in circlets
1: insertion of plates around primary circlet plates
2: both
3: insertion of plates exclusively in interarea
4: insert plate in circlets and in columns beneath basals (Acrocrinidae)
5, both (as in *Habrotecrinus*)

CA15 Consistent plating pattern (presumably under genetic control)
0: absent
1: present

CA16 "Gap" plate(s) in lowest calyx circlet
0: absent
1: present

CA17 Calyx sutures
0: surface flush between adjacent plates
1: impressed in a groove

INFRABASAL CIRCLET (IC)

IC1 Infrabasal circlet
0: absent
1: absent in adults
2: present in adults

IC2 Relative height of the infrabasal circlet
0: covered by column cicatrix
1: entirely in basal concavity
2: partially in basal concavity
3: along flat base of calyx (neither in basal concavity nor visible in side view)
4: plates wrap around from calyx base to side view of calyx
5: all plates in vertical wall of calyx
6: partially in basal concavity and wraps around to be visible in side view

IC3 Number of infrabasal plates
0: none
1: one
2: two
3: three
4: four
5: five
6: six

IC4 Infrabasal plate dimensions
0: W>H
1: H~W
2: H>W

BASAL CIRCLET (BC)

BC1 Relative height of basal circlet
0: covered by column cicatrix
1: entirely in basal concavity
2: partially in basal concavity
3: along flat base of calyx (neither in basal concavity nor visible in side view)
4: plates wrap around from calyx base to side view of calyx
5: all plates in vertical wall of calyx
6: internal rosette

7: partially in basal concavity and wraps around to be visible in side view
8: plates partially covered by infrabasals (as in *Homalocrinus*)
9: plates completely covered by infrabasals (as in *Homalocrinus*)

BC2 Number of basal plates
0: none
1: one
2: two
3: three
4: four
5: five

BC3 Basal plate dimensions
0: W>H
1: H~W
2: H>W

BC4 Basal plate, relative sizes
0: plates of equal size
1: subequal
2: unequal

BC5 All basals part of distal margin articulated to radial circlet (for calceocrinids)
0: no
1: yes

BC6 Number of basals in contact with basal concavity (for calceocrinids)
0: four
1: three
2: two
3: one

RADIAL PLATES (RC)

RC1 Radial circlet shape
0: radial
1: flat rectangular (for Calceocrinidae)
2: flat trapezoid (for Calceocrinidae)

RC2 Radial circlet interruption
0: absent
1: CD interray only
2: all interrays
3: more than one interray but less than five

RC3 Radial plates in contact laterally to basals and proximally to infrabasals (as in *Cleiocrinus*)
0: no
1: yes

RC4 Number of rays with radial plates
0: none
1: one (fused)
2: two
3: three
4: four
5: five

RC5 Simple radial plate dimensions
0: W>H
1: H~W
2: H>W

RC6 Supraradial plate dimensions (if compound radials)
0: W>H
1: H~W
2: H>W

RC7 Infraradial plate dimensions (if compound radials)
0: W>H
1: H~W
2: H>W

RC8 Superradial plates much smaller than inferradial plates (if compound radials)
0: no
1: yes supraradial <50% of inferradial

RC9 Relative height of radial circlet
0: covered by column cicatrix
1: entirely in basal concavity
2: partially in basal concavity
3: along flat base of calyx (neither in basal concavity nor visible in side view)
4: plates wrap around from calyx base to side view of calyx
5: all plates in vertical wall of calyx
6: partially in basal concavity and wraps around to be visible in side view
7: plates partially covered by infrabasals (as in *Homalocrinus*)
8: above aboral cup (as in *Tetragonocrinus*)

RC10 Radial plate largest plate in calyx
0: no
1: yes

RC11 C radial plate much smaller than other radial plates
0: no
1: yes

RC12 Radial plates unequal in size
0: no
1: yes

RC13 A-ray radial plate
0: absent
1: simple with one radial facet
2: compound
3: simple without a radial facet
4: simple with multiple facets
5: compound with multiple facets

RC14 B-ray radial plate
0: absent
1: simple with one radial facet
2: compound
3: simple without a radial facet
4: simple with multiple facets
5: compound with multiple facets

RC15 C-ray radial plate
0: absent
1: simple with one radial facet
2: compound
3: simple without a radial facet
4: simple with multiple facets
5: compound with multiple facets

RC16 D-ray radial plate
0: absent
1: simple with one radial facet
2: compound
3: simple without a radial facet
4: simple with multiple facets
5: compound with multiple facets

RC17 E-ray radial plate
0: absent
1: simple with one radial facet
2: compound
3: simple without a radial facet
4: simple with multiple facets
5: compound with multiple facets

RC18 E-ray inferradial-superradial sutural contact (for Calceocrinidae)
0: absent
1: long
2: short
3: narrowly separated
4: widely separated

RC19 Width of E inferradial relative to total hinge length (for Calceocrinidae)
0: 33 %
1: 67 %
2: 100 %

RC20 B and C inferradials fused (for Calceocrinidae)
0: yes
1: no
2: absent

RC21 B and C inferradials fused with A and D radials (for Calceocrinidae)
0: absent
1: present

RADIAL FACETS (RF)

RF1 Radial facet width and shape (5: fixed brachial above)
0: angustary <70 %width
1: peneplenary >70%
2: plenary (complete facet plenary)
3: inplenary (facets touching only adaxially)
4: explenary (facets touching only abaxially)
5: fixed brachial above
6: absent
7: multiple facets

RF2 Radial facet type
0: unifascial
1: bifascial
2: trifascial
3: multifascial

RF3 Straight fulcral ridge
0: absent
1: weak
2: strong

RF4 Axial nerve through radial facet
0: absent
1: single opening
2: double opening
3: triple opening

RF5 Radial facet orientation
0: sursumate
1: planate
2: declivate
3: vertical

RF6 Crenulae surrounding aboral ligamentary fossae
0: absent
1: present

RF7 On facet with aboral ligamentary fossae: grooves from margin to center of facet
0: absent
1: present and oriented toward midline and toward ambulacral groove
2: present and oriented toward midline and toward aboral side of plate

RF8 If plenary, …
0: explenary (facets touching only abaxially)
1: inplenary (facets touching only adaxially)

FIXED INTERRAYS AND BRACHIALS (FP)

FP1 Regular interray with fixed plates
0: absent
1: present
2: interlocking or loosely sutured (as in flexibles)

FP2 Regular interray proximal fixed plating (number of plates in first and second range)
0: none
1: one to two (1-2)
2: one to three (1-3)
3: one-one (1-1)
4: one to greater than 3 (1->3)
5; only one plate
6: multiple plates in first row

FP3 Approximate number of regular interradial plates
0: one to three (1-3)
1: four to twelve (4-12)
2: more than twelve (>12)

FP4 Regular interrays depressed
0: no
1: yes

FP5 Regular interrays with plating in biseries
0: no
1: yes

FP6 Position of distal-most interradial plates in relation to fixed brachials
0: primibrachitaxis
1: secundibrachitaxis
2: tertibrachitaxis
3: quartibrachitaxis
4: >quintibrachitaxis

FP7 Interrays
0: in contact with tegmen in all interrays
1: in contact with the tegmen in CD interray
2: not in contact with the tegmen

FP8 Fixed brachials
0: absent
1: present
2: interlocking or loosely sutured (as in flexibles)

FP9 Fixed rays symmetrical
0: absent
1: present

FP10 Median ray ridges
0: absent
1: present

FP11 Fixed first primibrachial shape
0: 4-sided
1: 5-sided
2: 6-sided
3: 7-sided
4: 8-sided
5: 3-sided

FP12 Fixed first primibrachial dimensions
0: W>H
1: H~W
2: H>W

FP13 Fixed brachials isotomously branched
0: no
1: yes

FP14 Distal most fixed brachitaxis
0: primibrachials
1: secundibrachials
2: tertibrachials
3: > quartibrachials

FP15 Fixed pinnules
0: absent
1: present

FP16 Fixed intrabrachials within a ray
0: no
1: yes

FP17 Position of highest intrabrachials plates
0: primibrachitaxis
1: secundibrachitaxis
2: tertibrachitaxis
3: > quartibrachials

FP18 Arm trunks
0: absent
1: present, with short trunk and few biserial arms
2: present, with long trunk and many biserial arms

POSTERIOR PLATING OF CLADID, DISPARID, FLEXIBLE, and ARTICULATES (PF)
[USE NAMES AND HOMOLOGIES IN 1978 CRINOID TREATISE]

PF1 Anal series articulated with C ray (for posterior of cladids, disparids, flexibles, & articulates)
0: no
1: yes

PF1a Radianal plate presence (proximal-most CD interray plate in cladids, disparids, flexibles, and articulates and in sutural contact with with infrabasal or basal circlet)
0 : absent
1: present

PF2 Radianal plate (proximal-most CD interray plate in cladids, disparids, flexibles, and articulates and in sutural contact with with infrabasal or basal circlet)
0: absent
1: simple
2: compound

PF3 Radianal (or Superradial) shape (for posterior of cladids, disparids, flexibles, and articulates)
0: pentagonal
1: hexagonal
2: septagonal
3: tetragonal
4: triangular

PF4 Radianal plate proximal width (for posterior of cladids, disparids, flexibles, and articulates)
0: full width beneath C radial plate
1: to left and below C radial plate
2: within radial/superradial circlet
3: To the left and above C radial/superradial

PF5 Radianal plate in contact proximally with (for posterior of cladids, disparids, flexibles, and articulates)
0: basal plates
1: infrabasal plates
2: superradial
3: radial

PF6 Anal X shape (for posterior of cladids, disparids, flexibles, and articulates)
0: tetragonal
1: pentagonal
2: hexagonal
3: heptagonal
4: octagonal
5; nonagonal
6: decagonal
7: triangular
8: ovate

PF7 Right tube plate shape (for posterior of cladids, disparids, flexibles, and articulates)
0: tetragonal
1: pentagonal
2: hexagonal
3: heptagonal
4: octagonal

PF8 Anal X position

Z: absent

ABOVE AND TO LEFT OF RADIANAL
0: above to left of radianal, lateral to D radial plate to left and right tube plate on upper right shoulder
1: above to left of radianal and on upper right shoulder of D radial plate
A: above to the left of radianal, lateral to C radial plate but not in contact with D radial plate
B: above to left of radianal and adjacent to both C radial (or superradial) and D radial (or superradial)

DIRECTLY ABOVE RADIANAL
2: directly above radianal and lateral to D radial plate and right tube plate on upper right shoulder
3: directly above radianal and on upper right shoulder D radial plate
C: directly above radianal, lateral to C radial plate but not in contact with D radial
D: directly above radianal and adjacent to both C radial (or superradial) and D radial (or superradial)

DIRECTLY ABOVE RADIAL (OR SUPERRADIAL) PLATE
4: directly above C radial plate (or superradial plate)

ABOVE AND TO LEFT OF RADIAL (SUPERRADIAL) PLATE
6: sutured above and to left of C radial plate (superradial plate) and on shoulder of D radial plate (superradial plate)
E: sutured above and to left of C radial plate (superradial plate) and not in contact with D radial plate (superradial plate)
M: suture above to left of C inferradial and laterally between C superradial and D radial plate

ABOVE PRIMIBRACHIAL
5: sutured above and to left of first primibrachial
7: above and left of radianal and lateral to D radial plate

DIRECTLY ABOVE CD BASAL PLATE AND RADIANAL ABSENT
8: directly above CD basal (radianal absent) and adjacent to C and D radials
9: directly above CD basal (radianal absent) and on shoulders of C and D radials
F: directly above CD basal (radianal absent) and above aboral cup
G: directly above CD basal (radianal absent) and adjacent to C radial plate but not D radial plate
L: D but not C

DIRECTLY ABOVE CD BASAL AND RADIANAL PRESENT
H: directly above CD basal and separated from radianal plate
K: directly above CD Basal and radial plate lateral to right

ABOVE AND TO LEFT OF CD BASAL
I: Anal X and radianal plate adjacent between C and D radial plates

CALCEOCRINIDS
J: directly above fused B and C superradials (subanal)

ACOLOCRINUS
K. Sits on top of cup wall at juncture between C and D inferradials and superradials"

PF9 Right tube plate position

Z: absent

ABOVE AND TO RIGHT OF ANAL X
0: above to right of anal X and lateral to C radial plate (superradial)
1: above to right of anal X and lateral to D radial plate (superradial)
7: above and to right of anal X and resting on upper shoulder of C and or D radial (superradial)
8: presumed right tube plate (plate to right and above anal X) and not in contact with either C or D radial (superradial) plate (in or out of cup)

DIRECTLY ABOVE ANAL X (RADIANAL ABSENT)
2: directly above anal X and lateral to C radial plate
3: directly above anal X and not lateral to C radial plate (above aboral cup)
9: directly above anal X and lateral to C and D radial plates;

ABOVE RADIANAL
4: above and to right of radianal, above and to right of anal X, and in contact with C radial plate
5: above and to right of radianal, above and to right of anal X, and not in contact with C radial plate

6: above (and to right of) radianal, above and to right of anal X, and lateral to the anal X and in contact with C radial

ADJACENT TO ANAL X
A: laterally between anal X and C radial plate;

ADJACENT TO ANAL X AND ABOVE ABORAL CUP
B: above radianal, above cup, directly adjacent to anal X

POSTERIOR PLATING OF CAMERATES (PC)

PC1 CD interray proximal plating (for posterior of camerates: P=primanal)
0: P-2
1: P-3
2: P-> 4
3: P-1
4: P (only)
5: multiple plates

PC2 Number of extra plates in CD interray (for posterior of camerates)
0: none
1: one or two (1 or 2)
2: three or four (3 or 4)
3: four
4: five or more (>5)

PC3 CD interray width in comparison with regular interrays (for posterior of camerates)
0: same
1: wider than
2: very much wider than high

PC4 CD interray (for posterior of camerates)
0: in contact with tegmen
1: not in contact with tegmen

PC5 Anitaxis plating (for posterior of camerates)
0: absent
1: present

PC6 Anitaxial ridge (for posterior of camerates)
0: absent
1: present

PERISTOMIAL REGION OF TEGMEN

PR1 Overall rigidity of plating
0: tessellate plating
1: imbricated
2: plates in a flexible integument
3: unplated (not due to lack of preservation)

PR2 Tegmen plate arrangement
0: radial pattern visible
1: plates homogenous, usually numerous, lacking obvious radial pattern
2: irregular plates and plating

PR3 True Orals (interradial) form a mouth ring below peristomial cover plates
0: absent
1: present, not covered by ambulacral plates
2: present, covered by ambulacral plates, except Oral 1

PR4 Oral 1 visible on tegmen surface
0: absent
1: present

PR5 Respiratory structures on modified oral plates
0: absent
1: present

PR6 Ambulacral cover plates
0: absent (but not from lack of preservation)
1: present at arm bases and extend to peristome region
2: present at arm bases but do not extend to peristome region

PR7 Ambulacral cover plates function
0: not tightly sutured, may have opened
1: fixed, differentiated from other tegmen plates and radiating from peristomial cover plates
2: fixed, undifferentiated from other tegmen plates

PR8 Ambulacra branch on tegmen
0: absent
1: present, axillary ambulacral cover plates swollen
2: present, axillary ambulacral cover plates not swollen
3: present, cover plates absent

PR9 Peristome
0: covered by peristomial cover plates (as in hybocrinids and cladids)
1: covered by true oral plates
2: open (for articulates – others?)

PR10 Peristomial cover plates
0: absent
1: differentiated, similar in size to ambulacral cover plates
2: differentiated, significantly larger than ambulacral cover plates
3: undifferentiated from other tegmen plates

PR11 Peristomial cover plates function
0: not tightly sutured, may have opened
1: tightly sutured, fixed

PR12 Interambulacrals (plates between ambulacra that are not true orals, or thecal plates)
0: none (as in hybocrinids; dichocrinids)
1: few in each interray (some cladids)
2: numerous in each interray (flexibles)

PR13 Hydropore
0: absent
1: present on oral

PR14 Goniopore
0: absent
1: present

PR15 Madreporite
0: absent
1: present

PR16 Ambulacra arrangement symmetry
0: 2-1-2
1: pseudo five fold
2: three-fold
3: four-fold

CLADID, DISPARID, FLEXIBLE, ARTICULATE TEGMEN (TF)

TF1 Anus position in CD interray
0: tegmen top, subcentral
1: tegmen top, eccentric
2: tegmen side
3: calyx side
4: elevated on anal sac (on top)
5: elevated on anal sac (~mid-height)
6: elevated to base of anal sac

TF2 Erect anal structure (for posterior of cladids, disparids, flexibles, & articulates)
0: absent
1: anal sac
2: anal papilla (small unplated structure on at least many articulates)

TF3 Anal sac plating
0: in vertical columns of aligned rows
1: in vertical columns of offset rows
2: irregular

TF4 Dominant column supporting sac
0: absent
1: present

TF5 Anal sac plate sculpturing
0: smooth
1: radiating ridges
2: nodose
3: vertical grooves and ridges
4: spinose
5: finely pustulose

TF6 Anal sac plate cross section
0: flat
1: plicated
2: convex
3: nodose
4: spinose

TF7 Anal sac shape (for posterior of cladids, disparids, flexibles, & articulates)
0: cylindrical
1: tapering distally
2: expanded distally, club-shaped
3: folded over
4: bulbous (e.g., *Coeliocrinus*)
5: spiral (e.g., *Streptocrinus*)

TF8 Anal sac "respiratory openings" (for posterior of cladids, disparids, flexibles, & articulates)
0: absent
1: sutural pores
2: slits

TF9 Anal sac spines at summit (for posterior of cladids, disparids, flexibles, & articulates)
0: absent
1: single spine on top of anal sac
2: multiple spines at summit of anal sac
3: "umbrella" of spines form roof of anal sac (composed only of spine plates)
4: "umbrella" of spines form roof of anal sac composed of both spine plates and extra plates

TF10 Arrangement of spinose plates if form roof over anal sac
0: spine plates continuous around periphery
1: spine plates separated by one or more non-spine plate around periphery

TF11 Anal sac spine shape
0: taper abaxially
1: expand abaxially

TF12 Anal sac spine cross section
0: circular
1: flattened oral-aborally
2: flattened laterally

TF13 Anal sac height
0: shorter than aboral cup height
1: higher than aboral cup approximately mid-arm length
2: approximately height of arms
3: higher than arms

CAMERATE TEGMEN (TC)

TC1 Tegmen height (height/width)
0: very high: > 2.0
1: high: 2.0 to >1.25
2: medium: <1.25 to >0.75
3: low: <0.75 to >0.50
4: flat: < 0.50

TC2 Tegmen shape profile
0: straight sides
1: convex sides -- widest at base if tegmen
2: convex sides -- widest above top of tegmen
3: concave sides

TC3 Tegmen height in relation to calyx
0: lower than calyx
1: tegmen approximately as high as calyx
2: higher than calyx

TC4 Rigidly plated tegmen
0: no
1: yes

TC5 Tegmen plate sculpturing, including anal tube
0: smooth
1: finely nodose
2: coarsely nodose
3: finely granulose
4: coarsely granulose
5: coarse irregular nodes and pitting
6: finely pitted
7: coarsely pitted
8: with ridges
9: with stellate ridges
10: spine
11: movable, articulated spines
12: concave

TC6 Proximal brachials fixed into side of tegmen
0: absent
1: present

TC7 Approximate number of tegmen plates
0: basically five
1: ten
2: 11-~50
3: >50

TC8 Tegmen plates gradational in size from abaxial margin to center
0: absent
1: present

TC9 Tegmen spines
0: absent
1: cylindrical
2: spatulate

TC10 Anus position
0: tegmen top, central
1: tegmen top, subcentral
2: tegmen top, eccentric
3: tegmen side
4: calyx side
5: from terminus of anal tube
6: mid-height of anal tube
7: base of anal tube

TC11 Anal tube (for camerates)
0: absent
1: present
2: very short raised cluster of plates

TC12 Anal tube plating (for camerates)
0: in vertical columns of aligned rows
1: in vertical columns of offset rows
2: irregular

TC13 Anal tube shape (for camerates)
0: conical
1: cylindrical
2: recumbent

TC14 Anal tube height (for camerates)
0: shorter than tegmen radius
1: higher than tegmen radius but shorter than height of arms
2: higher than height of arms

TC15 Anal tube spines (for camerates)
0: absent
1: present

TC16 Tubular tegmen extensions (*Gilbertsocrinus*)
0: absent
1: present

FREE ARMS (FA)

FA1 Arm openings into the calyx
0: none
1: three
2: four
3: five
4: ten
5: eleven to twenty
6: > 20
7: 6-9

FA2 Appendage type
0: true arms
1: uniserial armlets (as in *Acolocrinus*)
2: raised ambulacra but not arms

FA3 Arm habit
0: erect
1: pendant
2: fixed into wall of calyx
3: recumbent

FA4 Ambulacral floor plates in at least proximal free arms
0: absent
1: present

FA5 Proximal free arms projection
0: upward
1: outward and upward
2: outward
3: outward and downward
4: laterally

FA6 Maximum number of primibrachials (in B-E rays) [CODE whether fixed or free]
1: one
2: two
3: three
4: four
5: five
6: >five

FA7 Distal free arms are expanded or spatulate
0: absent
1: present

FA8 First primibrachial dimensions (NA if fixed brachials)
0: W>H
1: H~W
2: H>W

FA9 First primibrachial shape (NA for fixed brachials)
0: tetragonal (straight sided)
1: hexagonal
2: pentagonal (axillary) straight sided
3: pentagonal (axillary) concave sided
4: trapezoid
5, triangular
6: tetragonal (concave sided)

FA10 Free arm branching in secundibrachials and above (and lateral arms in Calceocrinidae; if fixed brachials only for free portion of arms)
NA: if atomous arms (5 arms or things like Catillocrinids)
0: none
1: isotomous
2: poorly isotomous
3: asymmetrical heterotomous
4: bilateral heterotomy
5: endotomous
6: exotomous

7: parapinnules
8: pinnate (in Calceocrinidae)
9: fused mesh (*Crotalocrinites*)
10: biendotomous
11: arm trunk (uniserial or uniserial to biserial) with bilateral heterotomous biserial arms
12: arm trunk (uniserial or uniserial to biserial) with exotomous biserial arms not fused abaxially
13: arm trunk (uniserial or uniserial to biserial) with exotomous biserial arms fused abaxially
14: arm trunk (multiserial) with bilateral heterotomous biserial arms

FA11 Ramule type (if heterotomous type branching)
0: simple
1: armlets

FA12 Maximum number of secundibrachials [CODE whether fixed or free]
NA: if atomous arms (5 arms or things like Catillocrinids)
0: one
1: two
2: three
3: four
4: five
5: 6 or more

FA13 Pinnulation
0: apinnulate
1: pinnules [definition in 1978 Treatise]
2: hyperpinnulation

FA14 Mature free arm brachials (terminology following Webster and Maples, 2008)
0: rectilinear uniserial
1: weakly cuneate uniserial
2: moderately cuneate uniserial
3: strongly cuneate uniserial
4: wedge biserial
5: round biserial
6: flat chisel biserial

FA15 Patelloid process
0: no
1: yes

FA16 First pinnule conspicuously larger than others
0: no
1: yes

FA17 E-ray branching pattern (for Calceocrinidae only)
0: atomous
1: isotomous
2: heterotomous
3: pinnulate [use Fig. 72 in 1978 Treatise (more detail coming)]

FA18 Main axil series with non-axillary plates (for Calceocrinidae)
0: no
1: yes

FA19 Main axil series branching (for Calceocrinidae)
0: isotomous
1: heterotomous

FA20 Robust beta ramules (for Calceocrinidae)
0: no
1: yes

FA21 Transition from proximal free brachials to mature free brachials
0: none
1: uniserial to biserial
2: one type of uniserial to another
3, one type of biserial to another

FA22 Number of primibrachials in A ray [CODE whether fixed or free]
0: same as other rays
1: atomous
2: first branching higher than other rays
3: first branching lower than other rays

FA23 Branching pattern in A ray same as in other rays [CODE whether fixed or free]
0: no
1: yes

FA24 Free arm branching on primaxil only [NA if fixed arms]
NA: if fixed or atomous arms (5 arms or things like Catillocrinids)
1: isotomous
2: poorly isotomous
3: asymmetrical heterotomous
4: bilateral heterotomy
5: endotomous
6: exotomous
7: parapinnules
8: pinnate (in Calceocrinidae)

FA25 Primaxil spinose or nodose [if in free arms]
0: absent
1: spinose
2: nodose

FA26 Primaxil spine length
0: less than width of primaxil
1: greater than width of primaxil

FA27 Primaxil spine shape
0: taper abaxially
1: expand abaxially

FA28 Primaxil spine cross section
0: circular
1: flattened oral-aborally
2: flattened laterally

FA29 Secundaxil and higher axillaries spinose or nodose [if in free arms]
0: absent
1: spinose
2: nodose

FA30 Secundaxil and higher axillaries spine length
0: less than width of primaxil
1: greater than width of primaxil

FA31 Secundaxil and higher axillary spine shape
0: taper abaxially
1: expand abaxially

FA32 Secundaxil and higher axillary spine cross section
0: circular
1: flattened oral-aborally
2: flattened laterally

FA33 Maximum number of "in line" bifurcations above radial plate [including any portion of ray fixed]
0: none (if 5 atomous arms or things like Catillocrinids)
1: one
2: two
3: three
4: four
5: five
6: six
7: > seven

FA34 A ramule in position of first pinnule
0: absent
1: present and unbranched
2: present and branched

FA35 Axillary arm plates with pinnules
0: absent
1: present

FA36 Proximal free arms with gaping sutures
0: absent
1: present

FA37 Laterally interlocking brachials in free arms
0: absent
1: between arms within individual ray
2: between arms of adjacent rays

COLUMN (CO)

CO1 Column
0: absent
1: present

CO2 Column attitude
0: erect
1: recumbent
2: planispiral coil
3: hanging (*Schyphocrinites*)

CO3 Proximal columnals cemented into calyx (as in *Apiocrinites*)
0: absent
1: present

CO4 Proxistele (proximal column) construction
0: holomeric
1: pentameric
2: tetrameric
3: trimeric
4: bimeric
5: hexameric

CO5 Mesistele (middle column) construction
0: holomeric
1: pentameric
2: tetrameric
3: trimeric
4: bimeric
5: hexameric

CO6 Dististele (column in holdfast sector) construction
0: holomeric
1: pentameric
2: tetrameric
3: trimeric
4: bimeric
5: hexameric

CO7 Proxistele (proximal column) heteromorphic
0: absent
1: present

CO8 Mesistele (middle column)
0: absent
1: present

CO9 Dististele (column in holdfast sector) heteromorphic
0: absent
1: present

CO10 Columnal shape in proxistele columnals
0: circular
1: pentalobate
2: pentagonal
3: tetralobate
4: tetragonal
5: elliptical
6: bilateral for planispiral coiling
7: decagonal

CO11 Columnal shape in mesistele columnals
0: circular
1: pentalobate
2: pentagonal
3: tetralobate
4: tetragonal
5: elliptical
6: bilateral for planispiral coiling
7: decagonal

CO12 Columnal shape in dististele columnals (in holdfast region)
0: circular
1: pentalobate
2: pentagonal
3: tetralobate
4: tetragonal
5: elliptical
6: bilateral for planispiral coiling
7: decagonal

CO13 Latus profile in proxistele
0: planar vertical
1: planar non-vertical (wider at base or top)
2: convex
3: concave

CO14 Latus profile in mesistele
0: planar vertical
1: planar non-vertical (wider at base or top)
2: convex
3: concave

CO15 Latus profile in dististele
0: planar vertical
1: planar non-vertical (wider at base or top)
2: convex
3: concave

CO16 Columnal height:width in proxistele
0: discoidal (H:W < 0.5)
1: elongate (H:W > 0.5)

CO17 Columnal height:width in mesistele
0: discoidal (H:W < 0.5)
1: elongate (H:W > 0.5)

CO18 Columnal height:width in dististele
0: discoidal (H:W < 0.5)
1: elongate (H:W > 0.5)

CO19 Lumen shape in proxistele columnals
0: circular
1: pentalobate
2: pentagonal
3: pentastellate
4: tetralobate
5: tetragonal
6: trilobate
7: trigonal
8: crescentic

CO20 Lumen shape in mesistele columnals
0: circular
1: pentalobate
2: pentagonal
3: pentastellate
4: tetralobate
5: tetragonal
6: trilobate
7: trigonal
8: crescentic

CO21 Lumen shape in dististele columnals (in holdfast region)
0: circular
1: pentalobate
2: pentagonal
3: pentastellate
4: tetralobate
5: tetragonal
6: trilobate
7: trigonal
8: crescentic

CO22 Columnal articulation type
0: symplexy, radial
1: symplexy in petals (perpendicular to sides)
2: synostosis
3: synarthrial
4: smooth

CO23 Areola
0: absent
1: present

CO24 Jugula
0: flat sided
1: constricted

CO25 Branching on column proxistele
0: absent
1: rhizoids
2: cirri

CO26 Branching on column mesistele
0: absent
1: rhizoids
2: cirri

CO27 Pattern of rhizoid/cirri
0: radial
1: asymmetrial/bilateral (myelodactylids)

CO28 Holdfast
0: absent
1: terminal rhizoids
2: runner rhizoids
3: terminal cirri
4: runner cirri
5: cemented
6: lobolith
7: coil
8: plated (lichenocrinus-type)
9: slightly expanded many plated
10: grapnel

CO29 Generating columnal between proxistele and mesistele
0: absent
1: present

RESPIRATORY STRUCTURES

RS1 Pore rhomb structures on calyx
0: absent
1: present

RS2 Pores at plate sutures
0: absent
1: present

LINTEL CIRCLET (LC)

LC1 Lintel circlet visible in lateral view (if used)
0: absent
1: present

LC2 Relative height of the lintel circlet
0: covered by column cicatrix
1: entirely in basal concavity
2: partially in basal concavity
3: along flat base of calyx (neither in basal concavity nor visible in side view)
4: plates wrap around from calyx base to side view of calyx
5: all plates in vertical wall of calyx

LC3 Number of lintel plates
0: none
1: one
2: two
3: three
4: four
5: five

LC4 Lintel plate dimensions
0: W>H
1: H~W
2: H>W