SECTION 2

ADVANCE SUMMARY OF THE PRESENT INVESTIGATION
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As indicated in Section 1, the metal ions selected for the present investigation are divalent cobalt (3\(d^7\)), divalent copper (3\(d^9\)), divalent cadmium (4\(d^{10}\)) and divalent mercury (5\(d^{10}\)). Their halides, nitrates, thiocyanates, selenocyanates and perchlorates were reacted with different polydentate ligands containing ONNO, ON–ON, ONS, ONO, ON, OS, NS, SS potential donor atoms. Further, some simple mixed ligand complexes and anionic mixed ligand complexes were prepared by reacting different nitrogen, oxygen and sulphur donor mono-, bi- and uninegative bidentate ligands. Also report has been made about the synthesis of some unusual penta-coordinated base-adducts. The coordination number of the complexes, thus isolated, is either 4, 5 or 6 and accordingly the stereochemistry is either square planar or tetrahedral for a coordination number of four, trigonal bipyramidal or square pyramidal for a coordination number of five and octahedral, distorted octahedral or tetragonal for a coordination number of six. The ligands used in the present investigation contain nitrogen, oxygen and sulphur donor atoms and are listed below.

Nitrogen ligands:
Pyridine, \(\alpha\)-picoline, \(\beta\)-picoline, \(\gamma\)-picoline, 4-aminopyridine, piperidine, morpholine, isoquinoline, quinoline, quinaldine, 2,6 lutidine, hydrazine, o-phenylenediamine, ethylenediamine, 1,2-diaminopropane, 2,2'-bipyridine, 1,10-phenantholine.

Oxygen ligands:
Acetoacetanilide, oxine, semicarbazone.
Sulphur ligands:
Thiourea, dithioxamide, piperidyldithiocarbamate, morpholyl-dithiocarbamate, thiosemicarbazone, N,N'-diphenylthiocarbazide.

Polydentate ligands:
The polydentate ligands are for the first time synthesised by us and attempts have been made to study their complexation behaviour with divalent metal ions.

Bis-(1,1'-dicyano-2-phenyl-2'-methyl ethylacrylate),
N,N'-bis-(acetoacetanilide)ethylenediamine,
N,N'-bis-(benzoin)ethylenediamine,
N,N'-bis-(benzoin)1,2-diaminopropane,
N,N'-bis-(benzoin)o-phenylenediamine,
N,N'-bis-(benzoin)m-phenylenediamine,
benzointhiosemicarbazone, benzoinsemicarbazone, benzoinphenylhydrazone,
benzoin 2,4-dinitrophenylhydrazone, schiff base: of benzoin with o-aminophenol, schiff base: of benzoin with 2-amino-2-methyl-1-propanol, schiff base: of benzoin with 1-amino-2-propanol,
Ethyl-1-phenyl-2-cyanoacrylate, ethylmethylketonethiosemicarbazone, N,N'-diphenylthiocarbazide.

The complex compounds isolated by reacting uni- and polydentate ligands with cobalt(II), copper(II), cadmium(II) and mercury(II) ions are listed below.

COBALT(II) COMPLEXES

(A) Cobalt(II) complexes with the tetradentate ligands of the compositions [CoLX₂], [CoL'X₂], [CoL"₂H₂O] where L = bis-(1,1'-dicyano-2-phenyl-2'-methylethylacrylate), L' = N,N'-bis-
(acetoacetanilide)ethylenediamine, $L'' = N,N'$-bis-(benzoin)1,2-diaminopropane, $X = \text{Cl, Br, NO}_3, \text{SCN, ClO}_4$.

(B) Polymetallic cobalt(II) complexes with bi-bidentate and tridentate biprotic Schiff bases of the type $[\text{Co}_2L_2\text{H}_2\text{O}]$, $[\text{Co}_2L'_2\text{H}_2\text{O}]$, $[\text{Co}_2L''_2\text{H}_2\text{O}]$ where $L = N,N'$-bis-(benzoin)m-phenylenediamine, $L' = \text{Schiff base derived from benzoin with 2-amino-2-methyl-1-propanol}$, $L'' = \text{Schiff base derived from benzoin with 1-amino-2-propanol}$, $L''' = \text{Schiff base derived from benzoin with o-aminophenol}$.

(C) Cobalt(II) complexes with tri- and bidentate ligands of the compositions $[\text{CoLCl}_2\text{H}_2\text{O}]$, $[\text{CoL'Cl}_2\text{H}_2\text{O}]$, $[\text{CoL''Cl}_2\text{H}_2\text{O}]$, $[\text{CoL}^{IV}_2\text{Cl}_2\text{H}_2\text{O}]$, $[\text{CoL'}^{IV}_2\text{Cl}_2\text{H}_2\text{O}]$, $[\text{CoL''}^{IV}_2\text{Cl}_2\text{H}_2\text{O}]$ where $\text{LH} = \text{benzoinsemicarbazone}$, $L'\text{H} = \text{benzointhiosemicarbazone}$, $L''\text{H} = \text{benzoinphenylhydrazone}$, $L'''\text{H} = \text{benzoin-2,4-dinitrophenylhydrazone}$, $L^{IV}\text{H} = \text{Schiff base of benzoin with aniline}$, $L^{V} = \text{dithioxamide}$, $L^{VI} = \text{ethyl-1-phenyl-2-cyanoacrylate}$, $X = \text{Cl, Br, NO}_3, \text{SCN, SeCN, ClO}_4$.

(D) Mixed ligand cobalt(II) complexes of the composition $[\text{CoL}_2L'_2]$, $[\text{CoL}_2L'']$ where $L = \text{oxine}$, $L' = \text{pyridine}$, $\alpha$-picoline, $\beta$-picoline, $\gamma$-picoline, $L'' = \text{ethylenediamine}$, $o$-phenylenediamine, 2,2'-bipyridine, 1,10-phenanthroline.

(E) Anionic mixed ligand complexes of cobalt(II) of compositions $[\text{B}_2][\text{CoCl}_4\text{L}_2]$, $[\text{B}_2][\text{CoCl}_4\text{L'}]$, $[\text{B}][\text{CoCl}_3\text{L}'']$; $[\text{QH}_2][\text{CoCl}_4\text{L}_2]$, $[\text{QH}_2][\text{CoCl}_4\text{L'}]$, $[\text{QH}][\text{CoCl}_3\text{L}'']$ where $B = \text{monomethylammonium cation}$, $\text{QH} = \text{quinaldinium cation}$, $L = \text{H}_2\text{O}$, $\text{pyridine}$, $\gamma$-picoline, $L' = \text{oxine}$, $1,10$-phenanthroline, $L'' = \text{thiourea}$, $\text{quinoline}$, $\text{piperidylthiocarbamate}$, $\text{morpholylthiocarbamate}$.
COPPER(II) COMPLEXES

(A) Copper(II) complexes with tetradentate ligands of the compositions
\([CuL], [CuL'], [CuL''], [CuL''']X_2, [CuL''''/]X_2, [CuL''''''/]\) where \(LH_2 = N,N'-\text{bis-(benzoin)}\)ethylenediamine, \(L'H_2 = N,N'-\text{bis-(benzoin)}\)o-phenylene-
diamine, \(L'' = \text{bis-(1,1'-dicyano-2-phenyl-2'-methylethylacrylate)},\)
\(X = \text{Cl, Br, NO}_3, \text{SCN, ClO}_4; L'''' = N,N'-\text{bis-(acetoaceta-
nilide)}\)ethylenediamine, \(X = \text{Cl, Br, NO}_3, \text{SCN, ClO}_4; L''''''H_2 = N,N'-\text{bis-(benzoin)-}
1,2-diaminopropane.

(B) Polymetallic copper(II) complexes with bi-bidentate and tridentate
biprotic schiff bases of the compositions \([Cu_2L_2], [Cu_2L'_2],\)
\([Cu_2L''_2], [Cu_2L''''_2]\) where \(LH_2 = N,N'-\text{bis-(benzoin)}m\)-phenylene-
diamine, \(L'H_2 = \text{schiff base of benzoin with 2-amino-2-methyl-1-propanol},\)
\(L''H_2 = \text{schiff base of benzoin with 2-amino-1-propanol, L''''H_2 =}
\text{schiff base of benzoin with o-aminophenol.}

(C) Copper(II) complexes with tri- and bidentate ligands of composi-
tions \([CuLCl], [CuL'Cl], [CuL'_2], [CuL''''_2], [CuL''''''_2], [CuL''''''''_2X_2],\)
\([CuL''''''''_2]X_2\) where \(LH = \text{benzoinsemicarbazone, L'H = benzointhiosemi-
carbazone, L''H = benzoinphenylhydrazone, L''''H = benzoin 2,4-}
dinitrophenylhydrazone, L''''''H = \text{schiff base of benzoin with aniline},\)
\(L''''''H = \text{dithioxamide, x = Cl, SCN; L' = ethyl-1-phenyl-2-cyanoacry-
late, x = Cl, NO}_3, \text{SCN, ClO}_4.\)

(D) Mixed ligand complexes of copper(II) [penta-Coordination] of the
composition \([CuL_2L']\) where \(LH = \text{chloroacetoacetilinilide L'} = \text{pyri-
dine, piperidine, quinoline, \(\beta\)-picoline, \(\gamma\)-picoline.}
(E) Anionic mixed ligand complexes of copper(II) of compositions
\[[B]\_2[CuCl_4L_2], [B]\_2[CuCl_4L'], [B][CuCl_3L'' \] where \(B\) = monomethyl-
ammonium cation, \(L\) = \(\beta\)-picoline, hydrazine, \(L'\) = oxine, \(o\)-phenylenediamine, \(1,2\)-diaminopropane, \(\alpha\)-picoline, \(L''\) = piperidyl-
dithiocarbamate.

**CADMIUM(II) COMPLEXES**

(A) Cadmium(II) complexes with tetradentate ligands of compositions
\[[CdL], [CdL'], [CdL'' \]X_2, [CdL''' \]X_2, [CdL IV] \] where \(LH_2 = N,N'\)-bis-(benzoin)ethylenediamine, \(L'H_2 = N,N'\)-bis-(benzoin)\(o\)-phenylenediamine, \(L'' = \text{bis-(1,1'-dicyano-2-phenyl-2'-methylethylacrylate)}, \(X = \text{Cl, Br, NO}_3, \text{SCN, ClO}_4; L'''' = N,N'\)-bis-(acetoacetanilide)ethylenediamine, \(X = \text{Cl, Br, NO}_3, \text{SCN, ClO}_4; L IVH_2 = N,N'\)-bis-(benzoin)-1,2-diaminopropane.

(B) Polymetallic cadmium(II) complexes with bi-bidentate and tridentate biprotic schiff bases of the type \[[Cd_2L_2], [Cd_2L'], [Cd_2L'' \] \], \[[Cd_2L''' \] \] where \(LH_2 = N,N'\)-bis-(benzoin)m-phenylenediamine, \(L'H_2 = \text{schiff base of benzoin with 2-amino-2-methyl-1-propanol}, L''H_2 = \text{schiff base of benzoin with l-amino-2-propanol}, L''''H_2 = \text{schiff base of benzoin with o-aminophenol}.

(C) Cadmium(II) complexes with tri- and bidentate ligands of compositions \[[CdLCl], [CdL'Cl], [CdL'' \] \], \[[CdL IV \]X_2, [CdL VI X_2, [CdL V'' \]X_2, [CdL V''' \]X_2, [CdL V IV \]Y_2, \[CdL V VI \]Y_2, \[CdL V'''' \]X_2, where \(LH = \text{benzoin semicarbazone}, L'H = \text{benzointhiosemicarbazone}, L''H = \text{benzoinphenylhydrazone}, L''''H = \text{benzoin-2,4-dinitrophenylhydrazone}, L IV'H = \text{schiff base of benzoin with aniline}, L IV' = \text{dithio-}
xamidé, \( X = \text{Cl}, \text{SCN} \); \( L^\text{VI} \) = ethyl-1-phenyl-2-cyanoacrylate,
\( X = \text{Cl}, \text{Br}, Y = \text{ClO}_4 \); \( L^\text{VII} \) = ethylmethylketonethiosemicarbazone,
\( X = \text{Cl}, \text{Br}, \text{SCN}, Y = \text{ClO}_4 \); \( L^\text{VIII} \) = N,N'-diphenylthiocarbazide,
\( X = \text{Cl}, \text{Br}, I, Y = \text{ClO}_4 \).

(D) Mixed ligand complexes of cadmium(II) [penta-ordination] of compositions \([\text{Cd}L^L_2L^L''] \), \([\text{Cd}L^L_2L^L'] \) where \( L = \text{piperidyldithiocarbamate} \), \( L' = \text{morpholyldithiocarbamate} \), \( L'' = \text{pyridine, } \alpha\text{-picoline, } \beta\text{-picoline, isoquinoline, piperidine and [hexa-coordination] of compositions } [\text{Cd}L^L_2L^L''] \), \([\text{Cd}L^L_2L^L'''] \) where \( L''' = \text{oxine, } L^{	ext{IV}} = \text{pyridine, } \beta\text{-picoline, } \gamma\text{-picoline, quinoline, 2,6-lutidine, piperidine, } L^V = \text{o-phenylenediamine} \).

(E) Anionic mixed ligand complexes of cadmium(II) of compositions \([B][\text{CdCl}_4L_2] \), \([B][\text{CdCl}_4L'] \), \([B][\text{CdCl}_4L''] \) and \([B][\text{CdCl}_3L'''] \) where \( B = \text{monomethylammonium cation, } L = \text{pyridine, p-picoline, } \gamma\text{-picoline, quinoline, 4-aminopyridine, piperidine, thiourea, } L' = \alpha\text{-picoline, quinaldine, 2,6-lutidine, } L'' = \text{ethylenediamine, o-phenylenediamine, 2,2-bipyridine, 1,10-phenanthroline, } L''' = \text{oxine, piperidyldithiocarbamate} \).

**MERCURY(II) COMPLEXES**

(A) Mercury(II) complexes of tetridentate ligands of compositions
\([\text{HgL}^L_2]X_2, [\text{HgL}^L']X_2, [\text{HgL}^L''] \) where \( L = \text{bis-(1,1'-dicyano-2-phenyl-2'-methyl ethylacrylate)}, X = \text{Cl, Br, NO}_3, \text{SCN}; L' = N,N'-bis-(acetoacetanilide)ethylenediamine, X = \text{Cl, Br, NO}_3, \text{SCN}; L'' H_2 = N,N'-bis-(benzoin)1,2-diaminopropane.\)
(B) Polymetallic mercury(II) complexes with bi-bidentate and tri-dentate biprotic Schiff bases of the compositions \([\text{Hg}_2\text{L}_2]\), \([\text{Hg}_2\text{L}'_2]\), \([\text{Hg}_2\text{L}''_2]\) where \(\text{LH}_2 = \text{N,N}'-\text{bis-(benzoin)m-phenylenediamine}, \text{L}'\text{H}_2 = \text{schiff base of benzoin with 2-amino-2-methyl-1-propanol}, \text{L}''\text{H}_2 = \text{Schiff base of benzoin with 2-amino-1-propanol}, \text{L}'''\text{H}_2 = \text{Schiff base of benzoin with o-aminophenol.}

(C) Mercury(II) complexes with tri- and bidentate ligands of compositions \([\text{HgLCl}]\), \([\text{HgL'C}l]\), \([\text{HgL''}_2]\), \([\text{HgL}^{IV}_2]\), \([\text{HgL}^{V}_2]\), \([\text{HgL}^{VI}_2]\), \([\text{HgL}^{VII}_2]\), \([\text{HgL}^{VIII}_2]\), \([\text{HgL}^{IX}_2]\), \([\text{HgL}^{X}_2]\), \([\text{HgL}^{XI}_2]\), \([\text{HgL}^{XII}_2]\), \([\text{HgL}^{XIII}_2]\) where \(\text{LH} = \text{benzoin semicarbazone}, \text{L}'\text{H} = \text{benzoin thiosemicarbazone}, \text{L}''\text{H} = \text{benzoinphenylhydrazone}, \text{L}'''\text{H} = \text{benzoin-2,4-dinitrophenylhydrazone}, \text{L}''''\text{H} = \text{schiff base of benzoin with aniline}, \text{L}^{IV} = \text{dithioxamide}, \text{X} = \text{Cl}, \text{SCN}; \text{L}^{V} = \text{ethyl-1-phenyl-2-cyanoacrylate}, \text{X} = \text{Cl}, \text{Br}, \text{I}; \text{L}^{VI} = \text{ethylmethylketone-thiosemicarbazone}, \text{X} = \text{Cl}, \text{I}, \text{SCN}; \text{L}^{VII} = \text{N,N'-diphenylthiocarbamide}, \text{X} = \text{Cl}, \text{Br}, \text{I}, \text{NO}_3, \text{SCN.}

(D) Anionic mixed ligand complexes of mercury(II) of the compositions \([\text{QH}]_2[\text{HgL}_2]\), \([\text{QH}]_2[\text{HgL}'_2]\) and \([\text{QH}][\text{HgL}''_2]\) where \(\text{QH} = \text{quinaldinium cation, L} = \text{pyridine, \gamma-picoline, L'} = \text{ethylenediamine, 2,2'-bipyridine, 1,10-phenanthroline, o-phenylenediamine, 1,2-diaminopropane, L}'' = \text{quinoline, piperidyldithiocarbamate, morpholyldithiocarbamate.}

The above metal complexes have been synthesised under appropriate conditions in pure state as is evident from their analytical data. Conductance measurements are carried out in acetone and dimethylformamide solution (0.001 M) using Toshniwal conductivity bridge, type CL.0102. Magnetic susceptibility measurements are carried out at
room temperature on solid specimen using Gouy method. I.R. spectra are recorded on nujol and KBr phase using Beckmen IR-12 and Perkin-Elmer-389, Perkin-Elmer-577 spectrophotometers, operating in the region 200-4000 and 400-4000 cm⁻¹ respectively. Electronic spectra are recorded in chloroform and dimethylformamide solutions (0.01 M) and nujol mull using Hilger and Watt uvispeck spectrophotometer. Thermogravimetry analysis are carried out on finely powdered samples by the Hungarian Optical Works, Hungary, in the ambient temperature of the furnace with heating rate of 10°C per minute. Molecular weight of the complexes are determined using Rast method.

The cobalt(II), copper(II), cadmium(II) and mercury(II) complexes listed under (A) are suggested to be either octahedral, distorted octahedral, square planar or tetrahedral in configuration. The tetradentate ligands reported here have been synthesised for the first time using benzoin, benzoylacetone and acetoacetanilide as the basic nuclei. These ligands possess ONNO potential donor atoms for coordination with the metal ions. IR spectra, especially absorption bands in the far infrared region have been extensively used to determine the coordination sites in the polydentate ligands. In addition, magnetic moment measurements, electronic absorption spectroscopy, thermogravimetric analysis, differential thermal analysis studies and molecular weight determinations have been of great help in elucidating the geometrical configuration of these complexes.

The novel complex compounds listed under (B) are mostly polymetallic complexes. The bi-bidentate and tridentate birectic schiff bases used here have been synthesised by us for the first
time having ON-NO and ONO potential donor atoms. Dinuclear octahedral configuration has been assigned to the cobalt(II) complexes whilst bimetallic square planar to the copper(II) and tetrahedral structures have been suggested to the cadmium(II) and mercury(II) complexes. In case of tridentate Schiff bases the dimerisation occurs either through the alcoholic or phenolic oxygen atoms as is evident from the i.r. spectra for the presence of the M<sub>2</sub> bridge. In case of bi-bidentate ligand, the spatial position of potential donor atoms favours the formation of polymeric compounds. Subnormal magnetic moments, spectral positions, high melting points, sparing solubility in common organic solvents support binuclear structures of Co(II) and Cu(II) complexes. Cd(II) and Hg(II) complexes are presumably polymetallic on the basis of analysis, conductance, sparing solubility, high melting point and i.r. spectral data.

The compounds reported under (C) are either octahedral, square planar or tetrahedral in configuration. A number of new tri- and bidentate ligands have been synthesised using benzoin and benzaldehyde as the basic nuclei. These ligands mostly contain ONO, ONS, ON, NS, potential donor atoms. The conclusive evidence of bonding of these polydentate ligands with the metal ions has been studied from the far i.r. spectra of the complexes.

The mixed ligand complexes of the type [ML<sub>2</sub>L'], [ML<sub>2</sub>L''] where M = Co(II), Cd(II) listed under (D) where L = oxine, L' and L'' are the nitrogen and sulphur donors, mostly belong to the usual hexa-coordinated variety as inferred from their analytical, conductance, magnetic moments, i.r. and electronic spectral data.
The mixed ligand copper(II) complexes listed under (D) of the composition \([\text{CuL}_2\text{L}']\) where \(L\) and \(L'\) are the chloroacetoacetanilide anion and the heterocyclic bases respectively are presumably penta-coordinated. From analysis, conductance, magnetic moments, i.r. and electronic spectral studies, these compounds are found to belong to the less common penta-coordinated class.

Cadmium(II) complexes of the type \([\text{CdL}_2\text{L}']\) where \(L\) = piperidyldithiocarbamate, morpholyldithiocarbamate and \(L'\) = heterocyclic amines are suggested to be less-common penta-coordinated variety as is evident from analysis, conductance and i.r. spectral data. In view of the absence of crystal field effect in case of Cd(II) ion, the formation of penta-coordinated complexes is not ruled out.

Anionic mixed ligand complexes of cobalt(II) mentioned under (E) and of mercury(II) in (D) are of the type \([\text{QH}]_2[\text{MC}_1\text{4}_{\text{L}2}], [\text{QH}]_2[\text{MC}_1\text{4}_{\text{L}'}]\) and \([\text{QH}][\text{MC}_1\text{3}_{\text{L}''}]\) where \(\text{QH} = \text{quinaldinimum cation}, L, L'\) and \(L''\) are the mono- and bidentate nitrogen and sulphur donor ligands. The complexes of the first and second categories are found to be octahedral and the third category are presumed to be pseudotetrahedral and penta-coordinated on the basis of analysis, conductance, magnetic susceptibility, i.r. and electronic spectral data.

Mixed ligand anionic complexes of cadmium(II) mentiond under (E) have the composition \([\text{B}_2[\text{CdCl}_4\text{L}_2]], [\text{B}_2[\text{CdCl}_4\text{L}']], [\text{B}_2[\text{CdCl}_4\text{L}''], [\text{B}][\text{CdCl}_3\text{L}''']\) where \(\text{B} = \text{monomethylammonium cation}\) and \(L, L', L''\) and \(L'''\) are the nitrogen donors. The compounds of the first and third categories belong to the octahedral configuration.
and the rest two types are presumably penta-coordinated as inferred from analytical, conductance and i.r. spectral data.

Anionic mixed ligand complexes of copper(II) mentioned under (E) belong to the penta- and hexa-coordinated class having the composition $[B]_2[CuCl_4L_2]$, $[B]_2[CuCl_4L']$, $[B][CuCl_3L'']$ where $B = \text{monomethylammonium cation}$, $L = 3$-methylpyridine, hydrazine, $L' = \text{oxine, o-phenylenediamine, 1,2-diaminopropane, 2-methylpyridine}$, $L'' = \text{piperidylidithiocarbamate}$. The complexes of the first and second categories except the 2-methylpyridine adduct belong to the more common hexa-coordinated class on the basis of conductance, magnetic moment, i.r. and electronic spectral data. Complexes of the third category including the 2-methylpyridine adduct possibly belong to the less common penta-coordinated class.

Anionic mixed ligand complexes of cobalt(II) of the compositions $[B]_2[CoCl_4L_2]$, $[B]_2[CoCl_4L']$ and $[B][CoCl_3L'']$ mentioned under (E) have been prepared where $B = \text{monomethylammonium cation}$, $L = H_2O$, $L' = \text{oxine}$, $L'' = \text{quinaldine, thiourea, piperidylidithiocarbamate, morpholylidithiocarbamate}$. The complexes of first and second categories are 1 : 2 electrolytes and the third type are 1 : 1 electrolytes. These anionic complexes belong to three categories, i.e. tetrahedral, octahedral and square pyramidal or trigonal bipyramidal. The complex compounds with quinaldine and thiourea adducts are deep blue in colour, have magnetic moments and electronic spectral bands, characteristic of typical tetrahedral Co(II) complexes. The compounds of the first and second categories are pink in colour and magnetic moment values, position of absorption bands and intensity support the spin-free octahedral configuration. Complexes with
Piperidyl and morpholyldithiocarbamates are olive green in colour, have magnetic moments in between tetrahedral and octahedral Co(II) complexes and the position of electronic spectral band differs from that of tetrahedral and octahedral compounds. Hence these two complexes are presumably penta-coordinated.

Apart from the evidence obtained in favour of bonding of the ligand donor atoms to the metal, the infrared spectra gave definite evidence for the presence of the following:

(i) $\delta$ M-O, $\delta$ M-N, $\delta$ M-S, $\delta$ M-Cl, $\delta$ M-Br
(ii) nature of bonding of the thiocyanate, selenocyanate, nitrate and perchlorate groups
(iii) presence of absence of coordinated water molecule
(iv) $\gamma$ C=C, $\gamma$ C=O, $\gamma$ C=N, $\gamma$ C=S, $\gamma$ C-O, $\gamma$ C-N, $\gamma$ C-Cl, $\gamma$ C≡N, $\sigma$ N-H, $\sigma$ NH, $\gamma$ OH etc.
(v) bridging oxygen atom.

Magnetic moment and electronic spectral data have been satisfactorily used in case of Co(II) and Cu(II) complexes to provide information regarding the probable stereochemistry of the complexes such as octahedral, distorted octahedral, tetrahedral, pseudo-tetrahedral, square planar and penta-coordinated. Thermogravimetry study of a few compounds have been undertaken to ascertain the composition of the complexes at different temperatures.

Most of the work has either been published or accepted for publication in various journals. A list of these communications is given below.
8. Complexes of Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) with chelating bidentate Schiff bases; J. Indian Chem. Soc.; 59, 988 (1982)
13. Polymetallic complexes Part (III): Schiff base complexes of
cobalt(II), copper(II), cadmium(II) and mercury(II) ions; Chemical Technology and Biotechnology; U.K., (In Press)


15. Complexes of Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) with chelating tridentate ligands, semicarbazone and thiosemicarbazone of benzoin; Indian J. Chem. (In Press)

16. ONNO tetradentate N,N'-bis(acetoacetanilide)ethylenediamine complexes of cobalt(II), copper(II), cadmium(II) and mercury(II); Transition Met. Chem. (In Press)

17. Complexes of Co(II), Cu(II), Cd(II) and Hg(II) with tetradentate ligand, methylene-bis-(1,1'-dicyano-2-phenyl-2'methyl ethylacrylate); J. Coord. Chem., (U.K.) (Communicated).

18. Complexes of Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) with chelating hydrazones; J. Indian Chem. Soc. (In Press).